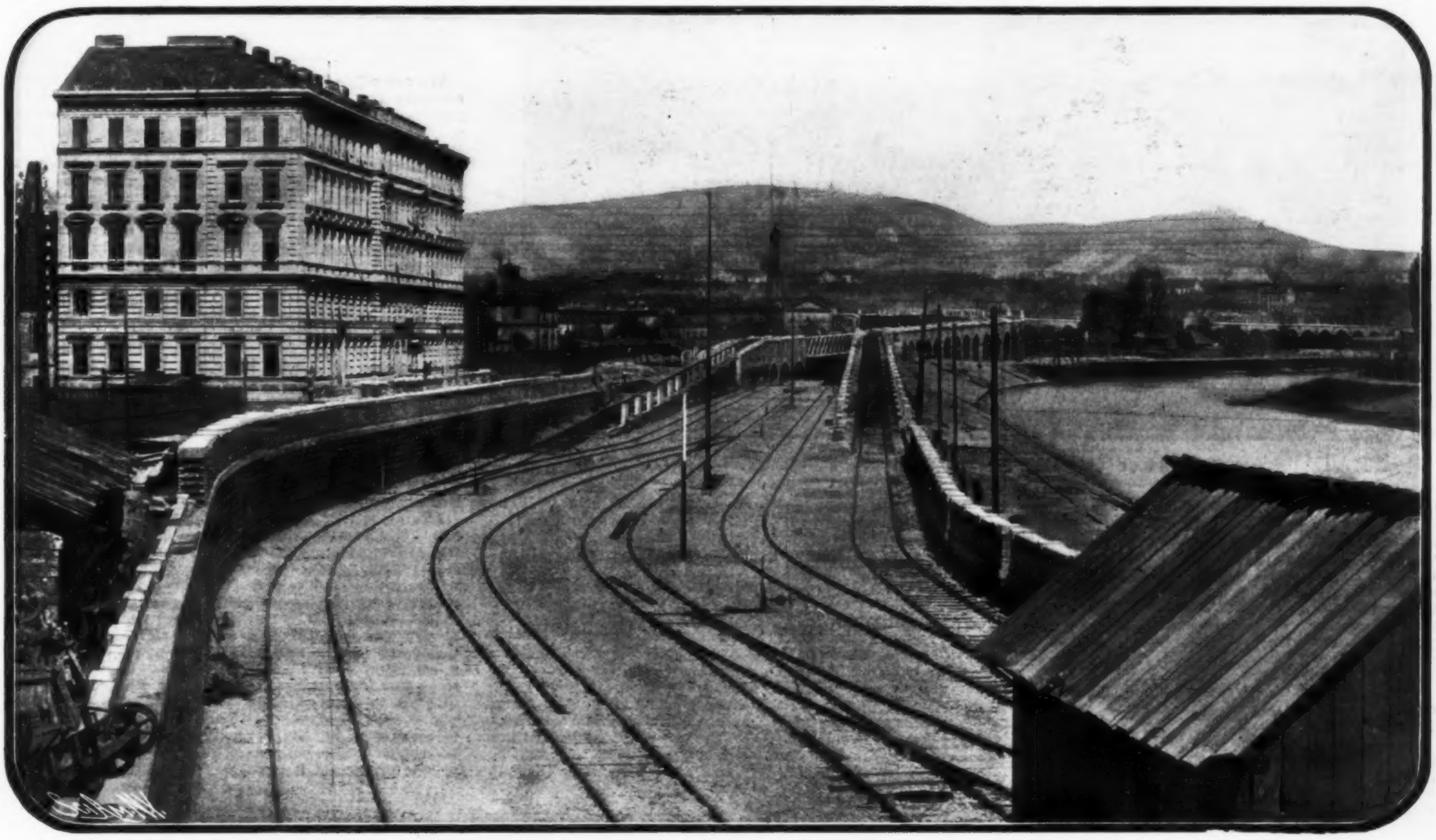
SCIENTIFIC AMERICAN SUPPLEMENT. No. 1456

Entered at the Post Office of New York, N. Y., as Second Class Matter.

Scientific American, established 1845.
Scientific American Supplement, Vol. LVI. No. 1456.

NEW YORK, NOVEMBER 28, 1903.

Scientific American Supplement $5 a year.
Scientific American and Supplement, $7 a year.



THE DANUBE CANAL LINE, AT THE POINT WHERE IT BRANCHES INTO ELEVATED AND SUBWAY ROADS.

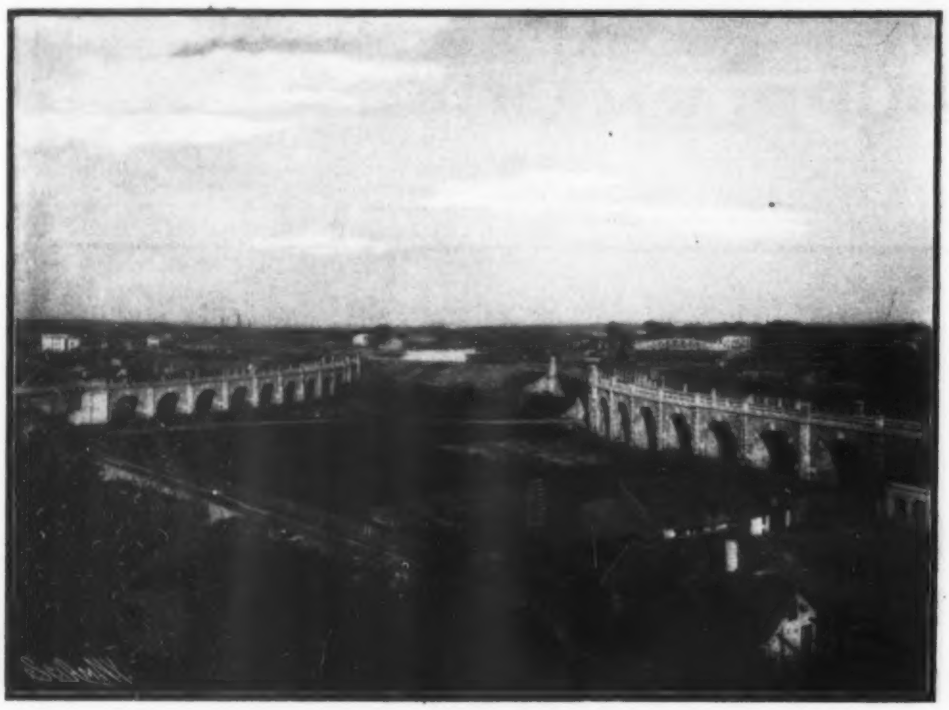
VIADUCT OVER THE FRANZ-JOSEF STATION.

THE VIENNA METROPOLITAN RAILWAY.

THE VIENNA METROPOLITAN RAILWAY.*

By Emile Guarini.

In consequence of the development of business, the necessity of constructing a metropolitan railway in the capital of Austria for the rapid transportation of the masses has been felt more and more for many years; and several projects for its construction were investigated. The following were the principles finally adopted: "The metropolitan railway should not serve solely for assuring the internal carriage of passengers between the different quarters of the city, but its essential object should be to facilitate relations between the center of the city and the remote outskirts and summer residences. In addition, it should serve for supplying the city with provisions, and, as far as the passenger service permits, be utilized also for the carriage of merchandise."



THE JUNCTION AT THE HEILIGENSTADT STATION.

The work has lasted for nearly nine years, and the cost of the first establishment amounts to 129,108,350 francs ($25,801,670).

The system comprises two main stations: Heiligenstadt, upon the Francis-Joseph Railway, and Hütteldorf-Hacking, upon the Empress Elizabeth line, or line of the West. The lines that start from these two stations are four in number—the suburban line, the belt line, the Vienna Valley line, and the Danube Canal line.

The suburban line starts from Heiligenstadt, follows the hillocks situated to the west of the city, and passes to the exterior of the Waehring, Hernals, and Ottakring districts, then to Breitensee, and finally to Penzing, where it ends. Its length is 7.6 miles. The line runs under the Türkenschanze through two tunnels 2,256 and 695 feet in length, and passes through a third tunnel 2,256 feet in length before reaching Breitensee.

The belt line first follows the Heiligenstadt one to Nüssdorf, and then it follows Gürtelstrasse until it joins, on the one hand, the Vienna Valley line near Lobkowitz bridge, while, on the other, it connects with the railway of the South. After passing, it runs along beside the two tracks of the Vienna line at Eger and Prague, and crosses Heiligenstadterstrasse over a bridge 184 feet long, and the Rue de Doebling over a bridge 108 feet in length, after which it continues on a viaduct as far as Michelbenem station, half of which is built in a cutting. The total length of this line is 6.75 miles, of which more than three thousand feet is in arched cuttings.

The Vienna Valley line starts from Hütteldorf and follows the course of the river as far as to the central custom house, making a connection with the Vienna junction line. It constantly follows the river either in an open or covered cutting. Its total length is 6.66 miles.

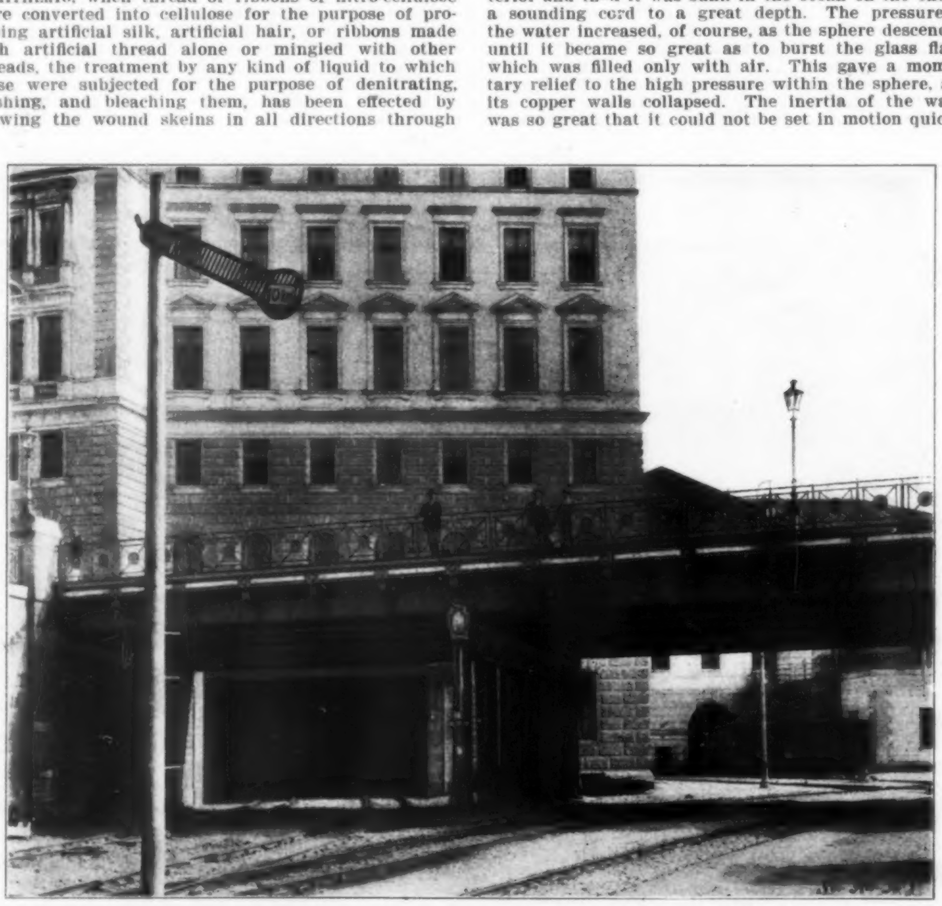
The Danube Canal line starts from the central custom house station, follows the Francis-Joseph quay, and then the right bank of the canal as far as Heiligenstadt, while a branch line passes over the station of the Francis-Joseph Railway and makes a connection between the Danube Canal line and the belt line. This branch line crosses the Vienna River over a sloping metallic bridge, and afterward follows the canal to Brigittabrücke. Upon this division, the covering of the cutting, on the side toward the city, rests upon a continuous masonry wall, and, on the side toward the water, upon masonry or cast iron pillars.

At Brigittabrücke each track divides into two. Of the two pairs of tracks thus formed, one runs to Heiligenstadt while the other regains the belt line by passing over the tracks that run to Heiligenstadt and those of the Francis-Joseph station. The maximum gradient of the four lines is respectively from .013 to 1.8 per cent for the first, 1 to 2 per cent for the second, .4 to 2.6 per cent for the third, and from .27 to 2 per cent for the fourth. The length of this last mentioned line is 18,480 feet, and the connecting line is 5,838 feet in length.

All these lines are of normal gage and are in direct communication with the great systems of the empire. The width of the tracks is 4.72 feet, and the minimum radius of the curves is 525 feet. There is an exception at the beginning of the Danube Canal line, near the Hauptzollant station, where the radius is 426 feet. The distance of the tracks, from center to center, upon the principal lines is 13.1 feet (between interior rails, 8.22 feet), and upon the secondary lines 12.46 feet. The maximum gradient of 2 per cent has been exceeded only for a length of about 125 feet, where it attains a value of 2.974 per cent. The free height under girders beneath the bridges is 15.75 feet.

(To be continued.)

* Specially prepared for the Scientific American Supplement.



ENTRANCE TO THE CHIEF CUSTOMS BUREAU STATION OF THE DANUBE CANAL LINE.

THE VIENNA METROPOLITAN RAILWAY.

MANUFACTURE OF ARTIFICIAL SILK AND HAIR.

Hitherto, when thread or ribbons of nitro-cellulose were converted into cellulose for the purpose of producing artificial silk, artificial hair, or ribbons made with artificial thread alone or mingled with other threads, the treatment by any kind of liquid to which these were subjected for the purpose of denitrating, washing, and bleaching them, has been effected by drawing the wound skeins in all directions through the different baths. In this way the thread was snarled, and it was afterward difficult to wind it anew. The thread also was injured by this rough mechanical manipulation, for, in the moist state, the thread of denitrated nitro-cellulose is not very resistant or elastic. To remedy this inconvenience, all mechanical movement of the product should be omitted during the denitration, the washing, or the bleaching. The matter to be operated upon can, according to the well-known principle of the circulating bath, be formed into skeins or spools, and thus treated by the liquid in circulation. The matter may also be denitrated, washed, or bleached by passing it through the liquid with the alternate employment of pressure and the vacuum, according to the principle of dyeing in spools. In this way the thread remains perfectly intact. After being denitrated, and without taking the parcels apart, it may be immediately washed, bleached, and dried.

To secure the denitration, washing, and bleaching, according to the process described, any appropriate bath can of course be employed; for denitration, it is advantageous to make use of a bath consisting of a solution containing 2½ to 6 per cent of sulphhydrate of potassium, sodium, ammonium, calcium, barium, strontium, or magnesium. With this bath, not only is the ordinary effect of the circulating bath produced, but it is considerably augmented. The reason lies in the fact that the solutions containing these percentages of the sulphhydrate mentioned do not diminish the force and the elasticity of the thread treated, while with the concentrated solutions of 10 per cent and more the thread loses its power and elasticity.—Translated from La Revue des Produits Chimiques.

EXAMPLES OF INERTIA.

We are all familiar with many experiments to demonstrate the inertia of matter, sometimes called the passiveness of matter—its dislike to get into motion when at rest and its desire to keep moving when once in motion. One of these is the old trick of firing a candle through a door panel. The candle travels so rapidly that when it strikes the door its particles do not have time to slide one upon another, and the soft candle flatten out, as would be expected; but instead it will crash through the wooden door, if we are to believe our text books. Whether it actually would do this or not can only be told by those who have performed the experiment, which would seem to be rather a dangerous one, owing to the possibility of bursting the gun. It is known, moreover, that a person hunting in the winter-time should be careful not to run the muzzle of his gun into the snow, lest the end of the bore become filled with snow and the gun burst when fired. While the snow would be almost infinitesimal in weight, it would have to start instantly into motion, at the rate of perhaps a third of a mile a second, when the powder ignited. While it may be hard to realize it, more force would probably be required to accomplish this result than the strength of the gun barrel could stand and the barrel would rupture under the strain.

Examples like the foregoing are very familiar, but some other tests quite as instructive, but more out of the ordinary, have recently been explained before the Royal Society of London. The tests were first made with a copper sphere about 5 inches in diameter, in the center of which was a glass flask about 1 to 1½ inches diameter, retained in position by cotton packing. The sphere was perforated to allow water to enter its interior and then it was sunk in the ocean on the end of a sounding cord to a great depth. The pressure of the water increased, of course, as the sphere descended, until it became so great as to burst the glass flask, which was filled only with air. This gave a momentary relief to the high pressure within the sphere, and its copper walls collapsed. The inertia of the water was so great that it could not be set in motion quickly enough to fill the space occupied by the glass flask before the collapse of the outer sphere. Another similar test was made with a copper tube, open at the ends, and containing a small glass vial. When sunk sufficiently deep the vial crushed, relieved the pressure within the tube and the latter collapsed, before the water had time to run into the ends of the tube for the support of the metal walls. These tests are all the more striking when it is remembered that the water was under such high pressure at the depth of the sphere or

tube, that it must have flowed at an extremely high velocity into the sphere or the ends of the tubes; but yet it was too late to prevent the action cited.—Machinery.

THE WATERTUBE BOILER IN THE BRITISH FLEET.*

By Archibald S. Hurd.

The truth about the Belleville watertube boiler in the ships of the British navy has yet to be written, and it must be some years before the whole story can be published, since the last chapter, recounting the tale of its practical working under sea conditions, is not yet ready to be set down. It seems more than probable that the future has in store for the prejudiced opponents of the new type of steam generator some revelations which will ill accord with their preconceived opinions. Too much haste has been shown in condemning a system which has hitherto been only imperfectly understood in England, and was originally carried out for the most part in an unworkmanlike fashion. At first the Admiralty blundered, probably not with their eyes shut. The British naval authorities are responsible to Parliament, and, in spite of all boasted free-trade principles, members of the House of Commons are protectionist on some points, and the Admiralty was wise in its generation. Not until most careful investigations of the working of the Belleville boiler in the French Messageries Maritimes and in some small British men-of-war of the torpedo gunboat type had been made, did the Admiralty decide to fit the Belleville boiler in some of the large ships then building for the fleet. It is admitted by the Independent Boiler Committee, after long inquiry, that at the time the Belleville was the *best boiler in the market*. Having decided in favor of the best boiler available, an ordinary business man would have sought the assistance of the inventor, the man who knew all about it, and would have invited him to make boilers for a ship and carry out a long series of experimental and instructional trials, say a run to Australia and back or to the far East, so as to obtain reliable data. The Admiralty found themselves in a difficulty. In the House of Commons members were becoming restive at the mere suggestion that a type of boiler invented by a foreigner was to be adopted for the British navy. The politician would have been surprised had he been told that many of the mechanical improvements in ship construction, armament, and machinery introduced into the fleet in the past half century had been the product of foreign brains, American, French, and Russian in particular. The adoption of a French boiler marked no departure from precedent. The Admiralty, however, felt that they were treading delicate ground, and they decided that although they were purposing to use a foreign design of boiler, they would have as little as possible to do with the inventor. He might tell them on general lines how he made his boiler, and they could not prevent his claiming the large royalty for which he stipulated, but all the work and as much of the material as possible should be British.

With blind energy British workmen were set to work to manufacture the Belleville boiler, and to fit it in some of the new additions to the British fleet then in process of construction. These men were entirely ignorant of all the niceties which the men of the French company had learned by long experience; they did the best they could in the exceptional circumstances. The Admiralty, thus intrenched, were able to assure the House of Commons that though they had been compelled to adopt a boiler designed by a foreigner, they were using British labor in its manufacture. In this manner were the M. P.'s and trade unions kept quiet, while the workmen proceeded with the task of building boilers of which they had little or no knowledge. The result was that the early boilers were not a success. When they had been installed they were handed over to engineer officers ignorant of their peculiarities, and were pressed to their full power the instant they were installed. It is no exaggeration to say that the repair of the early boilers turned out in these unpromising conditions cost not far short of half a million. It is now evident that this was due not to any inherent defect in the design, but to want of familiarity with minute but important details of design and workmanship by those who made them, and also by those who worked them when made. Gradually the Admiralty varied the material as laid down by the inventor. The boiler had given every satisfaction in the Messageries Maritimes as manufactured by the Belleville Company, but the British authorities substituted solid-drawn for welded tubes, and made a number of other alterations which have increased the outlay on each boiler by at least one-third.

After much delay and at great cost the British authorities learned how to manufacture the boiler more or less as the inventor intended that it should be made. Simultaneously they were able to train a large number of officers and men in the working of the new type of steam generator. The old-fashioned senior engineers for the most part still regard the Belleville with that natural suspicion which a man assumes toward any innovation which is introduced after he has passed his best years with some older type. In this instance the new is more delicate than the old, and the most has been made of this disadvantage, and too little has been said by the older engineer officers of the military benefits which the Belleville places at their disposal. The Scotch boiler required little attention in comparison with the Belleville, and it is but natural that men who have grown up with one system should regard with ill-concealed suspicion and irritation a new boiler system calling for careful study and endless attention.

In the face of all opposition, the Admiralty pressed on with the work of installing the new boiler in all the new ships of the British fleet, and for a time it seemed as though the whole efficiency of the British men-of-war had been sacrificed. In inexpert hands the new boiler proved not more, but less, efficient than the one it had displaced, and confusion reigned in face of what looked like an impending catastrophe—a fleet unable to steam. The conviction forced itself upon the public mind in England that the Admiralty had made a false step, and had committed the country to a type of boiler which would render the navy unfit for action and land the country in endless expense.

Experience in the past few months has shown that none of these gloomy prognostications was justified, and the Belleville boiler, far from proving a failure, has largely justified itself. In last summer's naval maneuvers 26 battleships and 43 large cruisers participated, and the only vessel which met with disaster was the cruiser "Blake," fitted with Scotch boilers of the familiar type. An explosion on board this vessel resulted in the loss of three lives. Twenty-one of the ships had the Belleville boiler. They were submitted to the most severe test to which any large fleet has ever been required to respond. Each ship had to steam during the preliminary operations in the South Atlantic a distance of from 2,000 to 2,500 miles, and in not a single instance did the boilers occasion trouble, apart, of course, from the minor adjustments necessary during a long cruise at a high speed.

One illustration provided during these operations will serve to indicate the virtues of this type of boiler. The armored cruiser "Good Hope" is famous, because it was in her that Mr. Chamberlain went out to South Africa. She left Portland and steamed to the Azores at a speed of 18 knots with perfect ease, and then she had orders to chase one of the cruisers of the opposite side. She coaled and stored ship at Portland with her own staff for 33 hours immediately before leaving for the Azores, and had steamed for 73½ hours at 18 knots when the chase of the enemy began. At this moment she had been eased to 9 knots for over half an hour to communicate with the senior admiral, Sir Arthur Wilson, but in seven minutes she was steaming 19 knots, and within the half hour she was going 22½ knots, with something in hand if the demand for greater speed had been made from the bridge. For over three and a half hours this speed was maintained, and then the quarry, which had had a start of 10 miles, was overtaken. The "Good Hope" then steamed to Lagos, on the Portuguese coast, where she arrived in good order to leave for the series of tactical exercises which had been planned for the combined British fleets.

Reference has been made to one ship specially, but the same general truth of the military efficiency of the Belleville boiler in competent hands could be illustrated by many other ships, for none of the Belleville-boilered ships, as has been mentioned, broke down through boiler defects under the heavy strain to which they were put. Trouble with the engines occurred in some of the newly-commissioned ships, but these troubles merely served to emphasize the truth that good work will be done by boilers and machinery when they are in charge of staffs who thoroughly understand them. In the British navy engineer officers are frequently placed at short notice, and too often in insufficient numbers, in control of engines and boilers of which they have little knowledge, and then the department marvels at breakdowns. It would be surprising if there were not disappointments under such conditions. The fact is that no ships give better results than those of the British fleet after they have been twelve months in commission, and the engine and boiler room staffs have become accustomed to the peculiarities of the mechanism of which they are in charge. After the British cruiser "Powerful" returned from three and a half years in the far East, she attained a better speed than when she left England. It is the wisest economy for a country which builds expensive ships to spare no money in the maintenance of the machinery. After all is said and done, a ship of war is merely a moving gun-platform, and its usefulness depends upon its ability to proceed to the scene of action in the quickest possible time. Everything may and probably will depend on the efficiency of the staff working below the protective or armored deck, and whether in reserve or in commission, the modern and delicate machinery of a warship should be in charge of reliable officers with a well-trained staff. A ship in reserve should be ready to go to sea with officers familiar with the engines and boilers immediately the authorities give the order, and the executive and other officers and the crew are on board. The fleet in which a wise extravagance is not practised in the engine and boiler rooms will fare badly in the next war.

The secret of success in the mechanical department of a warship lies in the intimate knowledge of officers and men of the machinery they are called upon to control. Under favorable conditions the Belleville watertube boiler and the lightly made machinery which is now fitted in British men-of-war give admirable results. Let us take the case of the cruiser "Spartiate," the ship which once had the worst name in the British service. She was upward of six years under construction, and when she was completed, difficulty was experienced on her trials. Everyone prophesied that the vessel would never be of much use. She hoisted her maiden pennant on March 17 last under the command of Capt. Alban Tate, and on the 26th left England for Hong Kong with a relief crew for the battleship "Ocean." Two of her engineer officers, Engineer-Lieutenants Edward Gaudin, the officer who was largely responsible for the introduction of the Belleville boiler into the British fleet, and Walter S. Hill, and only about twenty of their stokers and artificers, had had previous experience with the Belleville boilers. The run of 9,600 miles to the far East was made at an average speed of 13 knots, and the amount of coal consumed for all purposes was 3,000 tons. This amount compares favorably with the experience of the cruiser "Amphitrite," which used 4,200 tons for the same trip; while the "Blenheim," with cylindrical boilers and 2,000 tons less displacement, burnt no less than 4,000 tons, proceeding at an average speed of 11½ knots only. In comparison with both these vessels, the "Spartiate" proved herself economical in fuel consumption.

Only sixteen days were spent at Hong Kong, while the crews of the "Ocean" were exchanged, and the "Spartiate" then left for England under orders to carry out a series of trials on the way home. Between Hong Kong and Singapore a passage trial was made, occupying ninety-five hours, an achievement in traveling between these two ports. Another record was established between Singapore and Colombo, the journey being made in ninety-six hours. From Colombo to Aden a speed of 13 knots was maintained, and thence to Suez the "Spartiate" did 13½ knots. A one-fifth power trial was carried out between Port Said and Malta on the small fuel consumption of 1.9 pounds per indicated horse power per hour for all purposes. A four-fifths power trial was made between Gibraltar and Plymouth, with a consumption of 1.7 pounds, the journey from port to port being made in sixty hours, in spite of the fact that the ship had covered 19,000 miles by the time she reached England, with little or no time for carrying out more than minor repairs. The "Spartiate" made a stay of sixteen days in England, and then shipped a new crew, including stokers and artificers, and left for Gibraltar to take part in the maneuvers. She joined Admiral Sir Compton Domvile's fleet at Lagos, the base for the maneuvers. During the operations the "Spartiate" went for twenty-six and one-half hours at 19 knots, and then for ninety-six hours at 18 knots, and in the eight days covered by the operations traveled 2,900 miles. On August 22 she reached Portsmouth, having traveled 25,000 miles in a matter of five months, without experiencing trouble with her Belleville boilers. Slight defects in her condensers she did experience toward the end. The sister cruiser "Europe" did almost as well, steaming nearly as far without boiler troubles.

The British naval engineers recognize that the watertube boiler in one of its several forms has come, and has come to stay; and the younger men in particular are determined to make the best of the Belleville boiler which has been installed in so many ships, and is the boiler with which the British must work should war occur in the next few years. They claim, and quite rightly, that they must receive the aid of the Admiralty, and that they must have ample opportunities of becoming acquainted with the ships they are to take into action before the crucial moment arrives.

It may be that the future will produce a boiler requiring less nursing and less careful stoking than the Belleville, and anticipation is entertained that the solution of the boiler problem will not be long delayed. Engineering opinion in the fleet supports the action of the Admiralty in placing other types of boilers, the Niclausse, Dürr, Yarrow, and Babcock & Wilcox, in a number of new large ships, in order that each may be thoroughly tested under sea service conditions. In most of these vessels the power will be distributed, one-fifth being cylindrical and four-fifths watertube, in imitation of the method adopted in the German fleet. For harbor purposes, and at times for slow steaming, the cylindrical boilers will meet all requirements, thus effecting an economy in fuel and at the same time permitting the other boilers to be kept clean for immediate use if occasion warrants.

The British authorities recognize that the future of the watertube boiler will reach its maximum efficiency in conjunction with liquid fuel. Experiments in this direction have been in progress for some years, and they have been so far satisfactory as to justify two of the battleships of the Channel fleet, the "Mars" and "Hannibal," being fitted for the use of liquid fuel, and the new armored cruiser "Bedford" has also been equipped so as to burn oil. In this particular, again, the British authorities are following the example of the German fleet. Unfortunately, Great Britain has no such store of oil at her very doors as she has of steaming coal, though there are hopes that North Borneo may justify expectations in this respect. Until a supply of liquid fuel of the required quality is discovered on British territory, it would be madness to commit the British fleet to the use of a type of fuel that can be obtained only from a foreign source. It is, however, fully recognized that when the moment arrives—when a British supply has been found—the British naval authorities must be ready to take immediate advantage of the fortuitous circumstance. Liquid fuel can be more readily stored in home and foreign stations than coal, since it does not deteriorate as coal does; it can be more easily handled, thus abolishing the trying ordeal of coaling ship, which wears out the crews; it can be fed to the furnaces without great labor, and it will lead to a decrease in the boiler-room staff of twenty to thirty per cent, an item of great moment in view of the value of every inch of space in even the largest men-of-war. With liquid fuel, moreover, the watertube boiler, especially the Yarrow type now on trial, reaches its highest efficiency and suffers least wear and tear.

It has not been the writer's design in the above remarks to paint the Belleville boiler as a perfect steam generator; it is far from that. On the other hand, it is efficient when properly treated. In consequence of its installation, the ships of the British navy have not been reduced to the condition of "lame ducks," as has been represented in the House of Commons and in the non-technical press. Whatever the eventual type which all the turmoil will evolve, it is certain that on account of its facility in raising steam and its lightness, the watertube is the naval boiler of the future.

* Specially prepared for the Scientific American Supplement.

Mending India-Rubber Articles.—For mending rubber shoes, balls, hose, tires, etc., the Deutsche Chemische Wochenschrift recommends the following: Articles are first freed of adhering foreign particles and thoroughly dried. Varnish, as, for instance, on rubber shoes, is removed by means of emery paper or a file, and the part thus treated is well rubbed over with benzine. The edges of the hole are then painted over with a solution of Para caoutchouc in benzine, a fitting strip of natural rubber being laid over it and a solution consisting of 4 parts of benzine, 3 of carbon sulphide, and 0.18 part of sulphur chloride is applied to the edges by means of some cotton wool tied to a wooden holder, this solution serving to vulcanize and to increase the resistance of the rubber. The joined parts have, of course, to be well pressed together.

[Concluded from SUPPLEMENT No. 1455, page 23313.]

TANGENTIAL WATERWHEEL EFFICIENCIES.*

BEING AN EXPERIMENTAL INVESTIGATION OF THE RELATIVE VALUES OF DIFFERENT BUCKET SHAPES.

By GEORGE J. HENRY, JR., Member A. S. M. E., Associate Member A. I. E. E.

FIGS. 16 and 17 illustrate a needle nozzle under comparatively low pressure, and the water dust is here also

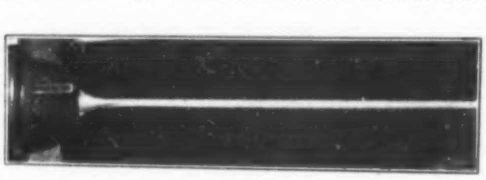


FIG. 16.—A STREAM OF WATER FROM A PELTON NEEDLE NOZZLE.

observable at from five to twenty stream diameters distant from the tip. In each of these cases the stream is in particularly good focus, and the water dust was more clearly observable in the investigations than it is shown in the photograph. It is perfectly obvious, if this theory is correct, that much of the wear that occurs in the interior of nozzle tips would also be explainable. For it is certain that where changes of cross section occur, there is a corresponding change in stream velocity, and, when this is not in accordance with the laws of least resistance, the oxygen or other gas would be released in exactly the same way—causing the pitting surfaces inside of the nozzle tip.

I believe this to be the correct explanation of chemical corrosion, and think that in most cases in practice we have a combination of chemical and mechanical erosion.

Paint acts exactly as a sheet of paper or rubber cushion protecting a piece of glass under a sand blast—the paper or rubber not in any way being damaged by the impact of the particles of sand, but where cut away so that the glass is exposed to the cutting grains, the

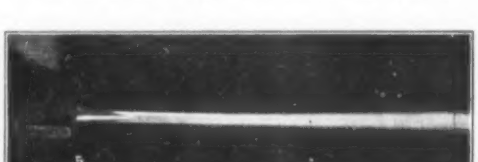


FIG. 17.—A STREAM OF WATER FROM A PELTON NEEDLE NOZZLE.

hard surface of the glass or of tool steel will be very rapidly cut. By holding your finger under the sand blast, the finger nail is rapidly cut away, although the sand makes no impression on the softer skin surrounding it. The observation of this fact led the Pelton company years ago to adopt a special rule in regard to painting its buckets—the paint proving the best possible protection. In fact, in regular operating plants, if the buckets are of good design and are kept thoroughly painted, they will last an indefinite length of time.

Considerable notoriety has been given to a large Pelton bucket originally in use at the Nevada Power Company's plant on account of the unusual amount of wear on the back. This has been explained by parties unacquainted with the facts as having occurred as shown in Fig. 18 (4).

Fig. 10 and Fig. 19 show a Pelton wheel in operation

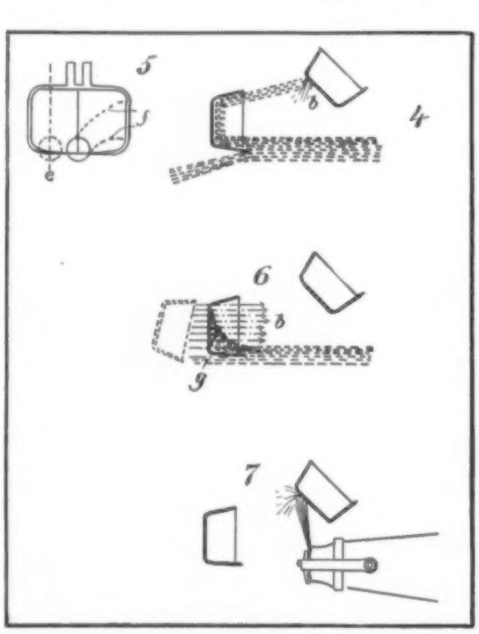


FIG. 18.

5 and 6. The path of water jet through the Pelton bucket. 4. A diagram sometimes used, but incorrect, to explain the wear that occasionally occurs on the backs of waterwheel buckets. 7. The correct explanation of wear on the backs of well-designed buckets.

at the point of best efficiency, and show that the water impact and discharge all occurs vertically under the wheel center and within a very short arc of stream contact; that there is no disturbance occurring in the stream itself due to the front wall of the Pelton bucket entering the stream.

Fig. 20 shows a Dodd wheel in operation when running at its best efficiency, and showing the discharge of the water through the front of the bucket at a point further removed from the wheel center than the entering water, as claimed in Mr. Dodd's patent.

The photograph also clearly shows the water entering one bucket but not yet leaving it, the bucket having to advance several stream diameters before it begins to discharge. The second and third buckets are also shown still receiving the stream, and the fourth bucket is shown with the water leaving it, although no water is entering.

Fig. 21 shows a wheel fitted with ellipsoidal buckets operating at point of best efficiency. One bucket has just started to enter the stream; the second bucket is in full action, the third bucket is just receiving the last particle of water, and the fourth bucket is just discharging the last particle of water. All of the buckets show clearly the loss of water through the open front wall, as pointed out above. This water still

FIG. 19.

Instantaneous photograph of tangential wheel fitted with Pelton buckets when running at high efficiency and showing the discharge from the sides of the buckets parallel with the entering jet. This photograph also shows clearly that the front of the Pelton bucket enters the stream without shock or disturbance of any kind and that all the energy is removed from the water by this shape of bucket.

contains considerable energy, resulting in a large falling off in efficiency. The efficiency of this type of bucket will decrease as the head decreases, the result being that, for large streams under low heads, such a large quantity of water is lost through the front opening as to very considerably reduce the efficiency below that obtainable with buckets having a front wall.

Fig. 23 shows one of the Pelton buckets at the Edison Mill Creek Station No. 3. This bucket was painted with one coat of asphaltum varnish, allowed to dry three hours, and then put under operation, driving a 750-kilowatt generator at about full load for a period of twenty hours, after which it was stopped, and this photo taken. The photo clearly shows, from the surfaces where the greatest amount of varnish is worn away, that the discharge occurred from the sides of the bucket and not from the top and front as has been sometimes claimed.

Fig. 22 shows an ellipsoidal bucket at the Edison Mill Creek Station No. 3, painted in the same way with a coat of asphaltum varnish, and operated for a period of seven hours, driving a 750-kilowatt generator at about full load. In this case the greatest quantity of wear has occurred from the front portions of the bucket, exactly as we would expect it from a study of the foregoing photos, the discharge occurring in exactly the same way as in the Dodd bucket (Fig. 20), with the exception that the Dodd bucket has caught all the stream, none of it discharging through the front wall.

The inevitable conclusions are that the greatest care and best judgment must be exercised in designing a bucket for each case. Certain it is, the bucket should have a front wall, joining cylindrical surfaces, which meet in a central apex or wedge, as distinguished from open front types and those having cups with deepest points in them, for the water to form eddy currents. It is a strange thing that mining companies will pay high prices for each inch of water, and then use it over cheap wheels, cheap only in first cost, but probably costing hundreds if not thousands of dollars each year in their extravagant use of water. Some power companies are doing the same thing, except on a more magnificent scale. This condition of things is similar to that case, all too frequently met with, of cheap steam engines and

FIG. 20

Instantaneous photograph of tangential wheel fitted with Dodd buckets and running at maximum efficiency, showing the discharge from the buckets to be below the point of entry and all of the stream fully caught in the buckets and reversed in direction, resulting in high efficiency.

boilers, whose extravagant use in coal constantly keeps the owner's nose hard up against the grindstone. There is, however, this difference: A good waterwheel, properly set and cared for, will always be efficient, if kept in good condition, whereas a good steam engine, if not in skilled hands, is more apt to deteriorate. A little conservative figuring will frequently demonstrate, beyond a doubt, that a property struggling along under a burden of indebtedness would be easily placed on a proper paying basis by the use of more efficient water wheels.

* A paper read before the Pacific Coast Electric Transmission Association at San Rafael, Cal., June 16, 1903. Copyrighted, 1903, by George J. Henry, Jr.

Modeling Wax.—Mix 6 parts of white wax, 1 of lard and 1 of chalk; work them up in the mortar until an intimate and homogeneous mixture is produced.

THE NEWCOMEN ENGINE.

MR. HENRY DAVEY delivered a short lecture at a meeting of the Institution of Mechanical Engineers. The printed pages of this lecture are supplemented by a number of appendices, and the walls of the Institution Hall were hung with drawings and photographs. The attendance was large. The applause with which Mr. Davey was received, and the dimensions of the assistance which had been given him by Sir Frederick Bramwell and many others in various places in the preparation of his lecture, testify to the interest which is taken in the history of the steam engine. It is well, we think, that the memory of the pioneers in mechanical science should be kept green. At no time more than now has it been desirable to claim for the people of this country the credit which belongs to them. If our readers will but think for a moment, they will satisfy themselves that in the race of progress Great Britain possessed at the start no special advantages over European nations. Coal and iron were as plentiful in Germany and in France as they were in England, Scotland, and Wales. The men were different; and, after all, it is men who make or unmake nations. It is impossible to overrate the importance of the work done by Newcomen, although he was totally unaware of that truth. In a way it was greater than that of Watt. At this time it would be waste of space to talk of what the steam engine has accomplished for the world. Newcomen was the first man to make a real steam engine. Mr. Davey told his hearers, in his lecture, all that is known about the man, and that all is very little. Nor is there any certainty of how and why he invented a steam engine. It is far from probable that in 1710 a Dartmouth ironmonger should have even heard of the French savant Denys Papin. No one else can claim the merit of inventing a cylinder and piston. But we must go even further than this, for Newcomen conceived the idea of utilizing a piston and cylinder for draining mines. With mines it is more than probable that he had some practical acquaintance. He would have known that an engine, to be of any use, must be large. But the magnitude of the work did not deter him. The pity is that no record remains of the successive steps which he took before pumping from a mine actually began.

The engineers of the present day, if we except a few surviving veterans, cannot realize the nature of the difficulties which Newcomen first, and even long after his day James Watt, had to overcome. Inventors in the early years of the eighteenth century had to consider first of all what things could and what could not be made. In the present day, any combination of mechanism that men can contrive, men can make. In Newcomen's time, it was almost imposible to get anything done beyond the simplest possible carpentry, smith's, and founder's work. Nearly half a century after Newcomen made his first engine, we find James Watt congratulating himself that nowhere was a large cylinder over ¼ inch out of truth. The more we think of Newcomen's difficulties, the more full of wonder we are that he ever succeeded in making an engine at all, much less one able to drain a deep mine. As Mr. Davey pointed out in the course of the discussion which followed his lecture, Newcomen had no works to go to to get what he wanted made. He had to rely on the village forge for his smith work, the country carpenter for his timber work. He went into partnership with a man named Cawley or Cowley—the spelling is uncertain—a glazier, and most likely a plumber. All the pipes about the first Newcomen engines were of lead. It is probable that it was for this reason that Newcomen associated himself with Cawley. Cylinders could not be made of iron. The art of founding did not go so far. They were made of brass. We have been told that at one time cylinders made of wood were used, and there is a record of a small Newcomen engine which had a cylinder made of leather. With such facts before us, we are better able to appreciate the dogged energy which possessed the men who first started Great Britain on the road to wealth and prosperity by developing her mineral resources.

It is a curious circumstance that Mr. Davey said very little about Smeaton's work. From 1718, when

Henry Beighton added the plug frame and so made the engine wholly automatic, until 1767, a period of nearly half a century, scarcely any improvement was made in machinery for draining mines. It is not easy to realize the fact that for so long a period the Newcomen engine did all the work that steam could effect. Then Smeaton took the matter in hand and made many experiments and many improvements, and so at last came James Watt with the separate condenser and air pump, which revolutionized the steam engine. Fortunately there are Watt engines in South Kensington Museum, from which can be learned the state of the mechanical arts at the time. Watt took out his first and master patent in 1769. His difficulties were, as we have said, not much less than those of Newcomen.

Although Mr. Davey confined his attention to the Newcomen engine, it must not be forgotten that various additions and alterations were made in it by several persons. The "pickle pot" separate condenser has been unearthed by Mr. Davey. It has never before been described. Again, the Newcomen engine was made to turn a crank, being, so far, the progenitor of the modern single-acting engine. All this required ingenuity, and that of no mean order. There was genius among the mining engineers of those days. But while we give credit without stint to Newcomen or Watt, the claims of a giant, intellectually and bodily, must not be overlooked. Richard Trevithick—"Captain Dick"—was a man who possessed in himself all the qualifications required in a great engineer. He was a Cornish man, a contemporary of Watt, and the apostle of high-pressure. In his day the biggest boiler plates were 3 feet long and 1 foot wide; riveting was so imperfect that rope yarn was interposed between the plates to make the seams tight. How shall we sufficiently admire the audacity of the man who worked such boilers at 150 pounds pressure, and that on no mean scale? "In 1813," wrote, in 1871, a contemporary of Trevithick's, "I carried rivets to make Captain Trevithick's boilers in the Millinear mine. They were 5 feet in diameter, and 30 feet or 40 feet long, with an internal fire tube. It took four or five months to build one. We had to hammer the plates into the proper curve. The rivet holes were not opposite to one another. A light hammer was held against the rivet-head in riveting in place of the present heavy one, so the rivet used to slip about, and the plates were never hammered home to make a tight joint." These boilers were intended to supply steam to work a pole pumping engine. Instead of a piston there was a plunger, because it was easier to get a plunger turned than a cylinder bored. The particular engine in question had a "pole" 36 inches diameter and 10 feet stroke. The turning was a bad job, and much trouble was experienced in getting the pole into the cylinder.

The story of Trevithick's life reads like a romance. We wonder if those of our readers who visit the Patent Office Museum at South Kensington, and see with their own eyes the old steam engines there, understand that the workmanship was what it was because no better could possibly be had. If the modern young engineer with his high college training and some familiarity with modern workshop tools and methods could be lifted back to the time of Newcomen or Trevithick, is it to be expected that he would do more than they did? The chances are that his very acquaintance with the way in which work might be done, and with the only way in which it could be done, would have so far disheartened him that he would have attempted nothing.—The Engineer.

QUEER OLD RAILROAD RULES.

In a brief paper read before the Engineers' Society of Western Pennsylvania on early experiences in transportation, Mr. Antes Snyder referred to the regulations promulgated for the control of traffic on the State railways of Pennsylvania. When the commonwealth opened the Philadelphia and Columbia Railway, the theory was that the State furnish the roadway and that any one who pleased could furnish his own vehicle and motive power and use the railway whenever he wished, by paying the State tolls for its use, just as the turnpikes of the day were used. But it was soon discovered that a certain character of vehicle was needed, and that rules and regulations as to times and manner of using the railways were absolutely necessary to effect their successful operation. The ordinary shippers found it too expensive to fit themselves with the necessary plant, and that they could get this transportation done by large and well-equipped shippers much more cheaply than they could do it themselves, so that in practice the business drifted into the hands of a few individuals and companies, who did this service for the many. The railway as constructed was intended for the horse as motive power, though the locomotive was being introduced as an experiment shortly after the railway was completed. The following among the rules and regulations adopted by the Canal Commission for the regulation of the railway, may be of interest:

"Section 92.—No car shall carry a greater load than three tons on the Columbia and Philadelphia Railway, nor more than three and one-half tons on the Portage Railway, nor shall any burden car travel at a greater speed than five miles per hour, unless the car body and load shall be supported on good steel springs.

FIG. 22.—ELLIPSOIDAL BUCKET AT EDISON MILL CREEK NO. 3 STATION.

Showing, by the wearing off of paint after seven hours run, that discharge occurs from the front of the bucket and not from the sides, as it should for best efficiency.

"Section 108.—It shall be the duty of the conductors of cars moving with less speed upon the railways, upon notice by ringing a bell, blowing a horn, or otherwise, of the approach of a locomotive engine or other cars moving in the same direction at a greater speed, to proceed with all possible dispatch to the first switch in the course of their passage, and pass off said track until said locomotive engine or other cars moving at greater speed can pass by. The conductors of the slower cars are directed to open and close the switches so as to leave them in proper order. Any person who shall refuse or neglect to comply with the provisions of this regulation shall, for every offense, forfeit and pay the sum of ten dollars."

FIG. 21.

Instantaneous photograph of tangential wheel fitted with ellipsoidal buckets and running at maximum efficiency, showing the losses that occur due to the stream's partly discharging through the front opening before energy has been taken out, and discharging from the front corners of the bucket, resulting in an unnecessarily large discharge angle, and reducing the efficiency of the wheel.

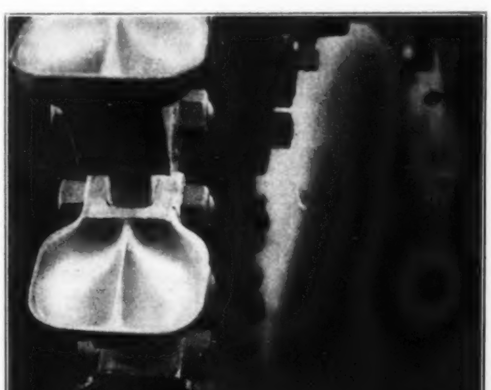


FIG. 23.—PELTON BUCKET AT EDISON MILL CREEK STATION NO. 3.

Showing, by the wearing off of paint after twenty hours run under 1,923 feet head, that the discharge occurs from the sides, as it should for best efficiency.

It must have been a very interesting and novel sight, indeed, when the horse and the locomotive were used indiscriminately on the same track and were struggling for supremacy as the future motive power of our railroads, and the approach of a locomotive was heralded by the tooting of a horn. Even at that time the right of way was given to the fast horse.

AN EXPOSITION FIGURE FACTORY.

By CHARLES DE KAY.

In Hoboken, where the Palisades are born, but where, thinking better of it, they immediately disappear, there is a district given up to coalbreakers and old railways so little used as to be grassgrown, to sheds and barns, blacksmith shops, and coal yards. Here are acres of cinders and piles of stone heaps, lines of coarse grass, where water lies, and pastures suddenly interrupted by short sections of canal, now black with mud, now brilliantly painted yellowish green with floating vegetation.

You walk to Schleicher's Point on a fine broad avenue, keeping the embryo Palisades on your left and just beyond the roadhouse you turn suddenly and plunge into a barnyard only to come up against endless coalbreakers. What a place for an etcher who finds beauty in the torn-down outskirts of towns! The mud and filth are deep, but the colors on the pools of manure are stunning in their manifold iridescence as they catch the light. Courage! There is a tunnel on the left under the coalbreaker, and when you emerge into chaos beyond you get another start, for there is a brand new roundhouse for locomotives, looking for all the world as if it had dropped from the skies. But such surprises are mere everyday matters in Hoboken.

Through the ample windows of this fan-shaped building weird, pale forms are seen, more surprising in their brilliant note of white because of the black surroundings. As the pearl is found in the dusky oyster, as the lily shines white above the swamp, so, in this dismal nook among the coal chutes and ramshackle buildings, do the candid forms of art appear—it is the Figure Factory for the St. Louis World's Fair.

Hither are brought the models fashioned with more or less talent, more or less success by a score of sculptors and sculptresses, to be dealt with by half a hundred busy men, measured and criticised and enlarged to the size required by an Exposition in which everything is to be on the scale of Brobdingnag. An enormous hand beckons you through the window; it is chalky white. A lady with a classic nose and a far-off yearning look on her regular features gazes from an upper casement, but it is with a stony stare not of this earth that she surveys the dismal outlook, as if the roundhouse were an insane asylum for white giants and she longed to be free.

The scene within is bedlam, indeed. The entire floor is covered with groups and single figures in every stage of preparation, motionless, but full of movement, dead as white plaster only is dead, yet alive with gesticulations and the flapping of draperies and banners. Here is a grave draped figure of a woman seated in deep thought, her braids falling on her enormous bare breasts, her draperies seized by some subterranean wind and thrown in big strong folds. There are Indians of the prehistoric legendary age, as to size, engaged in a frantic dance, their bare heads covered by buffalo skins with the horns attached, their hands clutching the sacred wands, their legs bent in the crouching, stamping buffalo dance. Yonder is a rollicking cupid, the size of a man, astride of a tortoise as big as the creature long extinct whose shell is found in Patagonia, and next him a river god rears his huge bulk and displays the might of his muscles, while a portrait statue of a departed worthy, an explorer or historical character, looks on benignant, as if he were used to lunatics from the world of white—Indians and cowboys whooping on their ponies, and colossal ladies "mid 'most nodings on" doing nothing, and young gentlemen clad each in a very handsome pair of wings, and symbolical figures lacking a shoulder or so or a leg, and seahorses with webbed hoofs springing forth from a solid wall, boys rolling over as they try to hold a big fish, or youths wrestling with bear cubs, animals that stand majestic by themselves or tumble about in sport, or else that form a humble part of a human group as a sign or a formula or a more decorative adjunct to the composition.

Over this wild scene of dislocated arms and legs, horses half clothed with skin, and white giants writhing headless, armless or legless, presides Mr. Karl Bitter, the director of sculpture for the St. Louis Fair.

COLOSSAL FIGURES OF STATES.

Sculpture at the Louisiana Purchase Exposition will be for the most part concentrated in one place. Up the Hill of the Arts, one will look and observe the cascade in front, and, to the right and left of the structure, crowning the height, two long porticos or stoas with the seated statues of the States of the Union between the columns. Here will be the colossal effigy of South Dakota, for example, modeled by L. O. Lawrie, a young sculptor unknown to fame hitherto. A big movement in this quiet Indian squaw, big planes of torso, of feature, of blanket round the legs. At her back is an oak stump with leaves adhering, and also a scythe, with its blade coming forward so that she holds the point with her left hand in her lap and wipes the steel down with the wisp of oak leaves in her right. She turns her head over her left shoulder, and the great thick plaits of hair fall straight. With the Indian type ennobled and made majestic, the sculptor has joined the idea of labor in the field as typical of the State. The figure must be twenty feet high as it sits.

Arkansas is a white woman by Albert Jaegers; she sits pensive and noble, regarding the cotton plant she holds in her left hand before her, while her right elbow leans on a couchant bear, emblem of the State. She, too, is nude to the waist, but her hair is filleted and her feet are shod with sandals, not with moccasins. The way of F. H. Packer, with his gigantic maid who symbolizes Nebraska, is another way. Her fine head and noble features do not save her from a certain coquettish air as she holds aloft a sheaf of wheat close to the wheat-heads that decorate her hair, as if to question whether enough be present. With her right hand she supports on her knee the shield that bears

the coat of arms of the State. There is a style about this figure, especially in the way the drapery is thrown about the lower frame, that suggests Martiny's work.

A fourth sculptor still new to exhibitions is A. C. Skodik, who embodies Montana in the seated woman with fine American face, draped from the shoulders down, holding the shield upright on the ground with her left, while her right hand lies loosely on her lap. Pick and shovel at her feet suggest the mines. Though she is so quiet and does so little, she is not the worst of the forty-four colossæ who will gaze from the colonnade down the slope of Arts Hill at St. Louis. North Dakota also comes off well with her effigy by B. L. Zimm. A beautiful torso is hers, and a spirited uplifted chin and a somewhat proud, if not disdainful, look. She rests her bare arms on the curving back of her chair. Wheat ears in her hair, wheat sheaves and a buffalo's skull near her feet, oak branches and leaves in the background—there she is, a beautiful young "touch-me-not" on the scale of the Titans.

Here are A. A. Weinman with a Kansas seated like Europa on a bull, which is lying at ease as the hand holding an ear of maize rests on its head, and A. Sterling Calder with a Missouri like a female Mercury holding the caduceus, and Carl E. Tefft, with an Iowa as a young, short-haired, somewhat masculine girl having scythe and shield, and A. Zeller, with a helmeted Colorado, an eagle crest on the helmet and both her hands resting on a miner's pick, and C. F. Hamann with a Wyoming who sits, one breast bare, the State shield on her lap, and Carl A. Heber with an Indian Territory in the shape of a squaw, looking down as she holds a sheaf of tobacco leaves near a great jar of pottery inscribed with Indian symbols. She has wheat sheaves at her feet and holds another straight up. This is one of the finest State figures yet produced.

SYMBOLS ON WIDER LINES.

There is to be a special monument referring to the purchase of Louisiana, and for the apex thereof, a hundred feet in the air, Karl Bitter has designed a figure of Peace draped to the shoulders, a youthful woman beckoning with an olive branch held high above her head, while her right hand is below the level of her waist and outward with palm downward. Her draperies swirl in picturesque folds, and on her head there is a diadem well back, set with five rays, each point perhaps to show at night a dim star.

Classic Art is modeled by F. E. Elwell as a laurel-wreathed woman draped in transparent silk, her right hand holding up a mask, her left supporting by her thigh a statuette of an Egyptian god. Gothic Art, by Johannes Gelert, is a handsome figure of a woman drawing her draperies to her breast, but leaving bare the lines from neck to foot on the left side; an end of the drapery falls over the left forearm. In the crook of her right elbow as she screens herself partially with the draperies, sits a little Gothic shrine.

By Isidore Konti are embodiments of the Atlantic and Pacific Oceans each a figure balanced on a sphere which rests on a pedestal bearing little Cupids playing with great fish. The Atlantic is a muscular youth with drapery swinging, who lifts his right hand high in a gesture claiming attention. At his feet an eagle stretches its wings as if still soaring. On the globe are big shells as decorations. The Pacific is a woman with similar flying draperies, her arms up at different angles and an albatross soaring at her feet. Seated female statues by Augustus Lakeman represent "Power," "Heat," "Speed," and "Light," decorative works rather than symbolical, to the hatching out of which no great time could have gone.

Much more care has been spent on the group by C. H. Niehaus, "The City of St. Louis and Guiding Spirits." The municipality is typified as a queen of the middle ages, crowned and seated in full drapery, who holds a long scroll with an inscription between widely stretched hands. Behind and to her left a nude genius with wings whispers in her ear with hand behind his mouth; behind and to her right another genius lifts arm and face to call attention to the message on the scroll. There is freshness and there is charm in the movement of the gay young whisperer and the immovable countenance of the woman with a mural crown make an effective contrast. Other symbolical groups are "Learning" and "Music," by George E. Bissell.

It is a talented young sculptor from the Southwest who knows the Indian and cowboy life, to whom four important groups have been awarded. Solon H. Borglum has prepared for as many longish pedestals formed by the side piers of stairways the following groups: "Indian Buffalo Dance," "Indian Advising Child of the Advance of Civilization," "Cowboy at Rest," and "Pioneer Looking for Shelter in Blizzard." The last is a bearded veteran like a trapper, extended on the ground and trying to shield himself from the fury of the wind, while his horse shows the force of the blast in his attitude and the blown tail and mane. The cowboy lies on his face in the shade of his saddled and completely accoutered horse, resting on his elbows and looking straight out over the plain. The Indian and child form a more complicated composition, in which the nude boy stands before the tall draped chief who is pointing over his head. A third figure crouched behind reaches forward to seize the knees of the chief. The Buffalo dance will attract most attention; it is in excessive motion. Three bucks in disguise as buffaloes are imitating at once the movements of the game and those of hunters. One leaps in the air, another steals along half crouched, and a third squats and jumps along. Each carries the talisman he has prepared. A fourth beats the rudest sort of drum, a hide stretched over a frame of wood. There is tremendous "go" in this group, while the others are restful.

Another group in this vein is Weinman's "Destiny of the Red Man," in which a buffalo marches along flanked by chiefs, a squaw and child, while overhead a veiled figure typifies fate. On a carved and decorated wooden post in the rear broods a vulture. The action of the several figures expresses haughtiness and stoical calm or anxiety. They have a movement in common and a general air of depression and sorrow which is shared by the buffalo, the vulture, and the dog in leash. This is an idea which may hereafter lead the sculptor to a very noble monument.

THE FOUNTAIN AND QUADRIGA.

The four-horse chariot, the Minerva, and lateral groups by Lopez and Roth will be one of the successes of the exposition, for the sculptors have managed to give the proper pompousness to the horses, joined as they are by thick garlands and led, two and two, by nude winged youths; yet in the side groups, consisting each of three draped girl figures, they have expressed a lively sense of gayety with the banner uplifted by the central girl of each trio and the long trumpets in the hands of the others. Minerva stands high in the chariot and holds up a torch in one hand and a statuette of Victory in the other. Her curious helmet makes an effective silhouette. The figures will stand at least one hundred feet above the level of the eye.

For the cascade a framework greatly elaborated has been prepared as the setting of the niche from which the waters are to gush. It is by H. A. McNeil. Above the arch in the center sits a goddess raising high a torch, with Beauty and her looking glass—or is it Truth unadorned?—below her to the left, and Justice with sword and scales on the other side.

Sea horses managed by lithe nude figures caracole on the sides; below them are floating figures in almost complete relief, blowing conches and holding palm branches. For the manufactures, two fountains with rearing sea horses have been designed by Martin, with Neptune standing in one shell-like sea-chariot and Venus in the other.

But this must be enough, for a complete enumeration would be too long. Grafly's "Truth," Bella Pratt's "Light and Darkness," and Alfaro's "Strength" deserve greater length of description than can be given here. The "figure factory," as it is known to Hoboken, is a hive of workers. As fast as they are finished, the big white groups are rolled out to a covered car, and one car after another speeds away to the banks of the Mississippi.

The value to young sculptors of such experience as they gain in work like this cannot easily be overrated. The necessity of composing on a big scale with attention to distant viewing, the absolute requirements of a time-limit for producing the small model, the lessons learned when they see that model in its larger estate, are inestimable for their development. The present stress and strain have brought out a number of sculptors who show every sign of promise for the future. When they see their work in place there will be another chance to rearrange their ideas of what sculpture ought to be, and come to conclusions by way of failures as often as by way of successes.—New York Times.

SOME NEW EXPERIMENTS IN SYNTONIC WIRELESS TELEGRAPHY IN THE ITALIAN NAVY.*

By the Belgian Correspondent of the SCIENTIFIC AMERICAN.

SOME experiments of considerable interest in syntonic wireless telegraphy have just been made in the Italian Royal Navy, which has, under many circumstances and in many ways, greatly contributed to the development of the Marconi system and to a furtherance of the results obtained thereby.

Although it is true that the experiments which we are about to describe are of a nature to interest all those who are closely or remotely watching the developments of wireless telegraphy, they are of still greater interest to the readers of the SCIENTIFIC AMERICAN SUPPLEMENT, because they agree at every point with the considerations and conclusions of our articles upon Marconi's work published in the issues of April 25 and May 2 and 9, 1903. In these we demonstrated the scientific possibility of syntonization and multi-communication, but in doing so made many reservations. We said especially that in order to obtain an efficient syntony, a syntony answering the object aimed at, most of the circumstances should be favorable, and nothing should be left to chance. We also made it apparent in several places, especially apropos of the experiments across the Channel, that syntonization is attainable only beyond a certain distance, a fact which is of importance, since it results therefrom that it is impossible for syntonization to effect a simultaneous communication in opposite directions, and such communication therefore becomes possible only by the limitation of the space through which the waves are sent and received.

All this is confirmed by the experiments of the Italian navy.

But there is another point that is worthy of our further interest, and that is the experimental confirmation of our assertion that syntonization, or, more exactly, the secrecy of the dispatches and the multi-communication aimed at, is not attainable with the magnetic detector. This point is of the greatest importance, since the experiments have also shown that the magnetic detector is more sensitive and certain than the coherer, which alone permits of syntonization. In our opinion, it may be concluded that the magnetic detector, combined with a limitation of space, would constitute the ideal receiver for wireless telegraphy. We have, moreover, our own reasons for believing, despite certain journals that make Marconi and the Wireless narrate so many wonderful things about syntonization, that Marconi and his company are the first to hold the opinion that it is not in syntonization, but in the limitation of space, that resides the future of wireless telegraphy, and that syntonization is, at the most, good only for obtaining better results from the energy employed, that is to say, for sending messages a greater distance with a certain energy. We have said, and for a reason, that Marconi and the Wireless are not deceived as to the value of syntonization. In fact, we owe it to the loyalty of the Marconi Company to say that, after having talked with its general superintendent as to the interest our experiments on the limitation of space would have for his company, he frankly told us that after our experiments were completed and had given decisive results, we might present an apparatus operating with certainty, and the company would then examine it with pleasure, and, if the results were convincing, would be pleased to discuss the terms of purchase of the invention. This declaration, we think, clearly expresses the ideas of the Marconi Company as to the problem of the secrecy of the dispatches, of which it, like ourselves, sees the solution in the limitation of space. It is well to say this, since in recent times the Marconi Company has usually been too often attacked apropos of the inefficiency of syntonization. As already stated in the columns of the SUPPLEMENT, we have obtained convincing results with short distances. Commercially speaking, however, they are not yet complete, and this compels us to maintain silence. These few indispensable considerations at an end, let us revert to the experiments of the Italian navy, in which special attention was paid to the form and height of the antennæ, and the spark-limit with a given antenna and receiver. The experiments relative to the use of limited antennæ and of reduced sparks, for the purpose of maintaining communications between neighboring stations without disturbing distant ones, were performed at Spezia, between the stations of the gulf and those of the ships at anchor, and were pursued on board of the ships of the squadron.

From such experiments, it results that with distances less than 20 kilometers (12½ miles), and with apparatus of B attunement, the use of simple antennæ about 20 meters (67.62 feet) high, and a 2 to 3 mm. (.078 to .118 inch) spark, is shown to be practical. In limiting in this way the energy set in motion, not only are distant stations not disturbed, but the rapid deterioration of the coherers is prevented, such deterioration being an inconvenience that manifests itself when too energetic waves are employed in short-distance transmissions.

Other experiments of the same kind were made between the stations of Palmaria, San Vito, and Leghorn, with the object of establishing the spark-limit to be employed between the above-mentioned stations with various types of antennæ and, consequently, of rendering it possible to limit the range of the radio-telegraphic station of Leghorn to the maximum necessary for communicating with the stations of the gulf of Spezia, thus assuring proper receiving with the Morse instrument without disturbing the more distant stations. For the Leghorn, Palmaria, and San Vito stations, B attunement was used, with single 170.6-foot antennæ for the transmitting as well as for the receiving station. During the communications, the spark was increased progressively from 2 mm. (.078 inch) to 9 mm. (.354 inch). The result was that, under such conditions, over a distance of 76 kilometers (47 miles), which is that from San Vito to Leghorn, the Morse apparatus required a 9 mm. (.354-inch) spark in order to receive properly, while with the magnetic detector, receiving was possible and satisfactory with sparks of but 2 mm. (.078 inch).

With antennæ reduced to 98 feet, even when employing 9 mm. (.354-inch) spark, no results were obtained with either the Morse apparatus or the detector.

With a single 170.6-foot antenna at the sending station, and four antennæ of the same height at the receiving station, satisfactory receiving was obtained at the distance of 47 miles with sparks of from 2 to 3 mm. (.078 to .118 inch).

This is the best proof of what we have believed since 1899, viz., that it is advantageous to employ multiple antennæ of large surface, especially at the receiving station.

Under conditions just the opposite of the preceding, i. e., with quadruple antennæ of the normal height at the sending station, and a single antenna of the same height (170.6 feet) at the receiving station, the distance being 47 miles, the spark necessary was 4 mm. (.157 inch) in length.

With a single antenna 164 feet high, and employing A attunement, good receiving was had over the distance of 47 miles by using sparks of from 5 to 7 mm. (.196 to .275 inch).

With an antenna quadruple the normal, and employing A attunement, always at the distance of 47 miles, good receiving was to be had with a 5 mm. (.196 inch) spark.

It should be observed that in these latter experiments with quadruple antennæ and A attunement, the station at San Vito always received regularly, while the station at Leghorn received but indifferently. As regards this, the fact must not be lost sight of that the station at San Vito was contiguous to a hill and in the vicinity of numerous ships at the arsenal, and of cranes, etc., and that, consequently, as Marconi thinks, there must have been a strong absorption of the energy indicated from the antenna of the station. Such absorption, insensible with B attunement, may be very sensibly felt with A attunement, which uses half the energy and shorter waves. For this reason, it may be necessary to employ a shorter spark for the inverse communications, being given the more favorable position of the Leghorn station.

On the other hand, it must not be forgotten that in establishing the rules for the quantity of energy to be employed with a given attunement, and, consequently, for the spark to be used for the various distances, the smallest spark that has been found to be applicable for a given distance (other conditions being equal) must not be prescribed, but rather a spark slightly larger.

It is well known, in fact, that for rendering signals exempt from atmospheric disturbances, especially during the summer season, there should often be applied to the apparatus appropriate self-inductions, which necessarily require an increase of energy at the transmitter in order that the receiver may continue to operate satisfactorily. Such a result evidently cannot be obtained if we prescribe a spark which does not develop at the radiator an energy a little greater than that which is necessary under the most favorable conditions.

An experiment at receiving was made at Palmaria also, the transmission being from Becco di Vela (a distance of 195 miles) by means of a 9 mm. (.354 inch) spark.

At Palmaria, the mast was raised about ten feet, but with little advantage for receiving, because the extension of the antenna was made with a single wire only, owing to the impossibility of elongating the four wires. The receiving was effected quite clearly by means of the detector.

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

The experiment showed that the ribbon of the detector should have but a very slow movement, say about four feet a minute. If the speed is less or greater, the sound at the telephone becomes considerably weakened.

Subsequent experiments confirmed the fact that Palmaria received in a satisfactory manner by means of the detector, without elongation of the antenna mast.

Leghorn transmitted with B attunement, a quadruple wire, and a 6 mm. (.236-inch) spark (distance from San Vito 47 miles); and Palmaria transmitted with A attunement, a single 115-foot wire, and a 2 mm. (.078-inch) spark (distance from San Vito 3.7 miles). San Vito received simultaneously with a quadruple antenna for A attunement, and a single 170-foot antenna for B attunement, as well as with a separate ground for each system. It became necessary to arrange the stations as above described in order to receive messages over both systems simultaneously. In other words, in order to favor the syntony and surmount the difficulty due to the great difference in distance of the two transmitting stations, it became necessary to increase the energy transmitted from the more distant station (Leghorn) and diminish that of the nearer one (San Vito). On the contrary, at the receiving station, it became necessary to increase the capacity of the antenna of the receiver of the nearer station, and, vice versa, to diminish that of the antenna connected with the receiver of the more distant station. In this way, various telegrams were received several times simultaneously. The experiment was followed by very good results, despite the bad weather; but it must be remarked that the difference in the distance separating the transmitting station from the receiving one, and the difference in the energy employed, are not conditions that can always be fulfilled.

Contrary to the preceding experiment, in which the more distant transmitting station was provided with the more powerful B attunement, an attempt was made at a simultaneous transmission by assigning to the nearer station the B attunement, and to the more distant one, the A attunement. Leghorn transmitted with the A attunement, a single 170.6-foot antenna, and a spark 8 mm. (.314 inch). Palmaria transmitted with the B attunement, a quadruple antenna, and a spark 1 mm. (.039 inch). San Vito received simultaneously and clearly with a quadruple antenna for the B attunement and a single antenna for the A attunement.

The attempt was even made at simultaneous receiving with a single antenna at the receiving station. Leghorn transmitted with A attunement, the same 170.6-foot antenna, and a spark of 10 mm. (.393 inch). Palmaria transmitted with B attunement, a quadruple antenna, and a spark of 1 mm. (.039 inch). San Vito used for receiving only one quadruple antenna for the two attunements. After several trials, the two messages were received separately and distinctly by the use of the following arrangements There were placed in series with the antenna using B attunement (Palmaria), 4 self-inductive resistances (of about 38 coils each), and between the binding posts of the jigger, a large vertical conductor. From between the binding posts of the antenna of the A receiver (Leghorn), a shunt of 5 self-inductive resistances and 50 turns of the induction coil (jigger) was run to the ground. Between the central binding posts of the jigger was placed a small condenser; and a separate ground was used for each receiver.

Just as brilliant results were also obtained with the A receiver non-shunted. An attempt was even made to communicate with Leghorn by employing A attunement, while Palmaria communicated with Castelfidardo, with B attunement. But it was afterward remarked that as a consequence of the proximity of this latter station to that of San Vito (about 1,300 feet), it was not possible to obtain a syntony, because the transmissions of Castelfidardo were received at the A receiver at San Vito, although self-inductive resistances were put in series with the antenna and in shunt with the antenna and the ground.

Several attempts were made at San Vito to receive simultaneously with a single quadruple antenna by using the following currents, antennæ, and sparks, to the transmitting stations of Leghorn and Palmaria:

Leghorn: B attunement; 174-foot antenna; 3 mm. (.118 inch) spark.

Palmaria: A attunement; 174-foot antenna; 3 mm. (.118 inch) spark.

It was decided to try the experiment by employing at the two stations the 3 mm. (.118-inch) spark that is commonly used for distances of about 100 kilometers (62 miles).

Aftesr a few trials, the two messages were received distinct and separate at San Vito by means of the following arrangements: At the B receiver (Leghorn), 50 coils of the wireless induction coil were connected in series with the antenna, and 4 self-inductive resistances of 38 coils each were connected in shunt with the antenna and the ground. At the A receiver (Palmaria), 3 self-inductive resistances were connected in shunt with the antenna and the ground. Each receiver was separately grounded, and each jigger provided with variable condensers.

Some more very satisfactory simultaneous receiving was accomplished by employing at Leghorn a 5 mm. (196-inch) spark, and, at Palmaria, a 2 mm. (.078-inch) spark, in connection with the following arrangements: At the B receiver, 25 coils of the wireless coil in series with the receiving antenna. At the A receiver, a self-inductive resistance of 38 coils in series with the receiving antenna. Separate grounds were also used, and B attunement, without a condenser between the binding posts of the jigger.

Finally an attempt was made at simultaneous receiving, with a common ground at the receiving station, or, more properly, with a common ground wire.

The registering machines had had an independent ground, because Marconi had declared it seemed to him that it was the active current which interfered with the receiving.

The two receivers were, on the contrary, grounded in shunt upon the ordinary ground wire of the station, and in series with one of the grounds were put a few self-inductive resistances. In this way, likewise, simultaneous receiving was had, but the experiment was almost always less of a success than in the case in which the two receivers had a separate ground.

A simultaneous transmission was successfully effected by placing at San Vito a quadruple antenna that was used in common by the A and B transmitters, with a single ground and a 3 mm. (.118-inch) spark for both attunements. At Palmaria, the receiving was done with the aid of a 173.8-foot antenna and the use of A attunement. At Leghorn, an antenna of the same height was used, together with B attunement. Palmaria and Livorno received very well; the first, however, received the two messages sent with the two attunements, by means of a self-inductive resistance of several coils in series with the receiving antenna.

We do not exactly understand why, in all these experiments, there is a continual talk about the length of the spark instead of the energy utilized, since with a spark of but 2 mm. (.078 inch), it is perfectly possible to bring into play an energy of several horse power (such is not the case here) if the capacity of the system is adequate. A definite length of spark is necessary in order to determine the difference of potential. A few data as to the energy employed would have been most interesting.

From all these experiments it may be concluded (1) that the great superiority of the detector over the coherer receiver, both as regards sensitiveness and constancy of operation, has once more been confirmed. This apparatus is, therefore, valuable for establishing communication with certainty when the operation of the ordinary receiver is not reliable because of accident, superabundance of atmospheric discharges, or too great a distance.

(2) In the experiments relative to syntonization, the coherer receiver was employed because syntonization cannot be obtained by means of the detector. The syntonization of the detector is yet to be studied.

(3) It is probable that a distance of 150 kilometers (93 miles) is the limit of range of A attunement, since, by making use of quadruple antennæ, it was found possible to receive satisfactorily at San Vito from the Leghorn station with a spark of but 5 mm. (.196 inch). According to Marconi, the orographic conditions of the San Vito station were very unfavorable for the A attunement, the waves of which are much shorter than those of the B attunement.

(4) It was found that the maximum range of the B attunement with the ordinary receiver, is 300 kilometers (186 miles), and that it is possible to reach 320 kilometers (198.7 miles), and even more, with the detector, by employing quadruple antennæ of about 165 feet and sparks of 10 mm. (.393 inch) at a maximum.

(5) The distances of less than 20 kilometers (12.42 miles), the use of simple antennæ of about 65 feet in height, with the B attunement and a spark of 2 or 3 mm. (.078 or .118 inch), was found practical.

(6) With a single 165-foot antenna, a spark of 6 mm. (.236 inch) is necessary for the A attunement and one of 9 mm. (.354 inch) for the B attunement (although this requires confirmation), in order to assure reciprocal communications at a distance of 76 kilometers, or 47 miles (Leghorn-San Vito).

(7) At the same distance, and employing antennæ of the same height, but single, for the transmitter, and quadruple for the receiver, a 4-mm. (.157 inch) spark suffices for satisfactory receiving with B attunement. At the above-named distance, it was impossible to establish communications with simple antennæ of 98 feet, even with the largest spark, but there are reasons for believing that, for distances of less than 50 kilometers (31 miles), such communications can be established.

(8) Syntony was obtained with both attunements by the Italian Navy Wireless Telegraph Corps, and the messages were kept distinct up to the distance of 6 kilometers (3¾ miles) under conditions as detailed above. It is probable that under such conditions the selection of the telegrams might be obtained at shorter distances, but not less than 500 meters (1,640 feet)—the distance at which (from Castelfidardo to San Vito) it was found impossible to distinguish the telegrams in consequence of the great excess of energy. However, a study of the shortest distance at which the syntonized apparatus give practical results will be the object of later experiments.

In the meanwhile, it may be anticipated that, *when the circumstances are favorable*, it will be possible to obtain with the syntonized apparatus that we now possess, a selection of the telegrams, even at distances less than 3¾ miles.

From all that we have just said it clearly results that, thanks to the Royal Navy of Italy, this new branch of telegraphy, this admirable vehicle of human thought, is making its way toward a sure application, military and well as commercial, in the country of Guglielmo Marconi. Nearly 22 ships of the Italian fleet are equipped with radio-telegraphic apparatus with coherer and detector receiver. By the end of next year, 37 stations will have been established on land and upon ships.

The superintendency of the radio-telegraphic service is now held by Corvette Captain Bonomo, to whom are directly responsible the various heads assigned to the different stations.

The experiments in progress are numerous and permit of the hope that radio-telegraphy will ere long, in Italy, enter into the field of the great commercial and public applications, while continuing to be of the greatest importance in the military domain.

It is needless to say that the experiments of the Italian navy will be watched with the greatest interest. It will be especially interesting to see whether the gigantic installation that is to be created in Italy will not annihilate communications between stations of less importance, and, if so, under what conditions. If it does not prove a success, it will be the best condemnation of gigantic stations; if it does prove a success, we can but rejoice over it because, in either event, the matter will be officially demonstrated.

Excavation for the lily and lotus lakes on the agriculture grounds at the World's Fair has been finished. Many of the willows and hardy aquatic plants that will line the banks have been planted.

CONTEMPORARY ELECTRICAL SCIENCE.*

RESISTANCE OF LEAD SULPHIDE.—The resistance of a solid is one of those properties which is practically untouched by theory. The variations of resistance are arbitrary and bewildering, and the observations of the same substance are often discordant. Streintz has found that compressed galena powder diminishes in resistance as the temperature rises, thus recalling the behavior of an electrolyte rather than a metal. In these circumstances it is interesting to find that E. van Aubel has observed the opposite behavior in a cylinder of fused lead sulphide, chemically pure, and measuring 6 mm. in diameter. At 20.7 deg. the resistance is 289.88 microhm-cm., and it diminishes constantly as the temperature is lowered down to the temperature of liquid air. Fused sulphide of lead, therefore, behaves like a pure metal. Its resistance at any temperature is some 5.000 times less than that of natural iron pyrites, which also behaves like an electrolyte. Guinchant believed that a minimum would be found in the resistance of lead sulphide at some temperature below —25 deg., but the author's measurements indicate no such minimum. There is a steady rise of resistance from the absolute zero, becoming rather more rapid as the temperature increases. When, after cooling in liquid air, the substance regains the ordinary temperature, it regains its original resistances.—**E. van Aubel**, Comptes Rendus, November 3, 1902.

ENERGY IN ETHER AND MATTER.—M. Planck discusses mathematically the energy emitted and absorbed by an ion swinging in an elliptic orbit, and endeavors to arrive at some conclusion with regard to the distribution of energy in ether and matter. He assumes that the movable ion forms with the fixed ion a doublet of neutral charge, whose moment alters very rapidly with the distance between the ions, this distance to be always small in comparison with the length of the wave emitted. To obtain the energy emitted by a doublet, the author describes a sphere about it whose radius is a mean between the dimensions of the doublet and the wave-length, and applies Poynting's theorem. He finally arrives at an equation representing the motion of an ion swinging in a nearly elliptical orbit, emitting energy by radiation, and absorbing energy from incident radiation. He further arrives at the conclusion that the entropy of a system in any condition only depends upon the "probability" of that condition. That distribution of energy between matter and ether will be most stable which admits of the greatest number of mechanical and electrical "complexions"—i. e., distributions of atoms and electrons in various combinations of position and velocity. The laws of radiation show that the mass of an atom or molecule is 1.62×10^{-24} times the mass of the gramme-atom or gramme-molecule. The charge of the electron results as 4.69×10^{10} electrostatic units.—M. Planck, Ann. der Physik., No. 11, 1902.

MAGNETIC PROPERTIES OF BISMUTH.—L. Lownds has continued his researches on the properties of crystalline bismuth by measuring the change of electric resistance in a magnetic field, the Hall effect, and the ratio of the electric and thermal conductivities parallel and normal to the principal crystalline axis. As regards the magnetic change of resistance, the figures show that that increases considerably on lowering the temperature, probably because crystallization is more complete then. But cooling below —79 deg. seems to have no advantage, and, indeed, only produces the reverse effect upon the resistance normal to the principal axis. The curves of change of resistance for various fields converge toward zero at a temperature of about 45 deg. The highest variation of resistance recorded is 62 per cent at —79 deg., with a field of 5,000 units. The Hall effect in a field of 4,000 units is greater at 16 deg. than at —79 deg., and is reversed at —186 deg. For —79 deg. it has a maximum in a field of 3,000 units. The E. M. F. of the thermo-magnetic transverse effect is greatest in the direction parallel to the crystalline axis, in which the change of resistance is also greatest. Apart from this fact, no distinct connection can be traced between the thermal and electric properties of bismuth.—L. Lownds, Ann. der Physik No. 11, 1902.

ATOMIC WEIGHT OF RADIUM.—Madame Curie maintains, in reply to the criticism of Runge and Precht, that the atomic weight of radium is not 258, as they suppose, but within a unit of the value of 225, as originally stated by her. The value 258 was arrived at by extrapolation from a study of the series of spectrum lines in accordance with Kayser and Runge's rule. On the other hand, Madame Curie's value was obtained chemically from two radium chloride preparations, one of which exhibited the three strongest barium lines clearly, while the other only showed traces of two of them. The former gave a mean value of 223, and the latter of 225. If 258 were the true atomic weight of radium, these preparations ought to have contained 19 or 20 per cent of barium chloride. In that case, it is unaccountable that the barium lines should be nearly invisible in one of them. That the two chlorides are isomorphous is no argument against their successful separation, since they have a difference of solubility. Radium, which was discovered spectroscopically by Demarçay, is one of the best defined and most characteristic of the chemical elements.—Mme. Curie, Phys. Zeitchr., May 15, 1903.

E. M. F. OF A THERMO-COUPLE.—An inequality of temperature between two adjoining sections of a homogeneous conductor brings about a difference of potential which is a function solely of the temperature as long as the physical or chemical state of the metal is not involved. M. Ponsot works out thermodynamically the following theorem: In every section of a conductor, unit quantity of electricity utilizes the fall of temperature of an invariable quantity of entropy. Admitting the relation of Liebenow, and L being independent of θ, we should have R/θ = constant, and R would be zero at the absolute zero of temperature. This zero of resistance is closely approached, as we know, by some pure metals. If, for determining the constants of any given thermo-couple, the data of any

* Compiled by E. E. Fournier d'Albe in the Electrician.

given thermometer are accepted for a given interval of temperature, the author believes that that thermometer does not give an exact scale of absolute temperatures, unless that scale coincides along its whole length with that of the thermo-couple.—Ponsot, Comptes Rendus, October 27, 1902.

THE CENTRAL AMERICAN RUBBER TREE.*

INVESTIGATIONS AND EXPERIMENTS.

By O. F. Cook.

Among the more striking results of the industrial progress of the nineteenth century was the rapid multiplication of the uses of rubber and an ever-increasing demand for the raw material. For several decades the world's needs were met by the Para district of eastern Brazil, but with steadily advancing prices as an inducement the entire Amazon Valley, and indeed all tropical regions of both hemispheres, have been ransacked in search of additional wild supplies. It is not yet true, as sometimes represented, that the natural product is exhausted or that a rubber famine is to be anticipated at an early date. Within the last decade the value of good grades of rubber passed from the neighborhood of 25 cents to a dollar and upward per pound, and the rubber-gathering industry met with an expansion sufficiently rapid to more than keep pace with the demand, so that a period of somewhat more moderate prices has ensued. But with a steady increase in the use of rubber in the arts and no very general improvement in the destructive methods of gathering the wild product, it is to be expected that this respite will be brief and that the question of the world's future supply will soon become more acute.

The preservation of the wild rubber forests is naturally receiving more and more attention in the countries in which they are so important a source of wealth, but measures of safety are least likely to be applied in the very remote and unexploited districts where they would do the most good. Rubber is still very largely a product of savage rather than of civilized industry; in fact, it is now by far the most important contribution of barbarous races to our industrial civilization. While this continues to be the fact there will be little change in the careless and wasteful methods of the past, but the appreciation of rubber forests as permanent sources of income may be expected to increase, so that the continued advance in the price of rubber no longer means merely the rapid extinction of wild rubber trees, but implies also increased interest in the protection and improvement of the more productive natural forests. Such a tendency is already manifest, especially in Brazil and in adjacent countries of South America, and probably means that the natural supply of rubber will never entirely cease, but will gradually become the basis for the development of scientific forestry in the tropics. There is, however, no probability that any large proportion of the present producing areas will become permanent sources of supply, and the cultural production of rubber well deserves the serious consideration it is now receiving in all agricultural regions of the tropics.

Rubber culture is no new or recent proposition, since beginnings were made nearly three decades ago. With an annual plant twenty years of experience would teach us much, but for dealing with long-lived trees that period is very short, and it need not be a matter of surprise that rubber culture is still in the experimental stage. Many cultural mistakes are still made with plants that have been in domestication for thousands of years, and the failure of the first attempts with rubber might have been predicted simply on the grounds of probability. Nevertheless, a distinct period of discouragement resulted, the effects of which are still felt and will doubtless remain until more detailed knowledge makes plain the possibility of avoiding the obstacles previously encountered.

Progress in practical matters as well as in purely scientific subjects depends much upon theories. On the failure of the first experiments, the theory that rubber trees could be profitably cultivated was discarded by many who came to the conclusion that planted trees will not produce rubber. This view is by no means extinct, especially among those who have abandoned rubber planting in disgust. An adverse opinion of this kind is popular with some because it serves as a general explanation of failure and spares the annoying suggestion of cultural errors and oversights.

Like other members of the vegetable kingdom the performances of rubber trees have been found to depend upon the conditions under which they grow, whether planted or self sown, unless they were injured in planting. In the American tropics and in the East Indies the possibility of the cultural production of rubber has been demonstrated. This fact is giving the pendulum the return swing in the direction of sanguine expectations, and the assurance that rubber can be produced culturally is too often taken as a verification of the original estimates of yields and profits in spite of the fact that some of these have been disavowed by their authors. A future of easy prosperity for the rubber planter is held to be assured, and the opinion that rubber culture is still experimental is resented as blindly conservative. The lesson of the former miscalculation is forgotten by the new generation of promoters, and the fact that rubber trees have been found to thrive in a given locality is taken as sufficient evidence that they will meet even the most reckless estimates of productiveness and profits. The opening of large plantations under untried conditions in Porto Rico and the Philippines is advocated, and the investing public is assured, in effect, that the returns from rubber culture are to be so great that the exercise of ordinary agricultural skill and business caution is unnecessary, though the fact remains that a large measure of both is likely to be required if the numerous unsolved problems of the new industry are to be overcome without ruinously expensive experiments.

PLANTED CASTILLA TREES ABOUT FOURTEEN YEARS OLD.

THE STATUS OF CASTILLA RUBBER CULTURE.

Many current discussions turn upon the question whether rubber culture is still in the experimental stage. This is the most frequent objection of those who lack confidence in rubber culture, and naturally arouses a strong protest from those who insist that rubber planting is the safest and most remunerative branch of agriculture.

It is true that rubber culture is no longer a new idea, since it was considered by the government of British India as early as 1872, and Castilla was introduced into India in 1876. The Hon. Matias Romero, formerly minister from Mexico to the United States, also began to write on the subject of rubber culture in 1872. But the success of rubber culture can scarcely be demonstrated from the experiments of twenty or thirty years ago, since the results of few, if any, of these appeared sufficiently promising to justify their continuation. The plantation of Señor Romero was located in the Soconusco district of the State of Chiapas, in southern Mexico, and was early abandoned. The small plot of trees visited by the writer at La Zacualpa, some 60 miles northwest from Tapachula, was probably planted as a result of the interest aroused by Señor Romero in this vicinity. The trees at La Zacualpa were set, however, as shade for cacao, and not as an independent culture. This was not the only experiment with rubber planting in the same region, but it seems to have been the only one which resulted favorably enough to call for the further investment of capital in the commercial production of rubber.

There have been, and still are, three general opinions regarding rubber culture. The first is that rubber can be produced at a profit wherever the trees will grow. The very frequent failure to secure rubber in paying quantities from planted trees gave rise to the second opinion that rubber could not be produced in cultivation. But these ideas are beginning to give place to the third and more rational view that rubber, like other agricultural crops, can be produced profitably only under favorable conditions, or, in other words, rubber culture may be said to have reached the stage when it can no longer be indiscriminately advocated nor indiscriminately condemned. If no other evidence were obtainable, the planted trees visited in Soconusco would prove that rubber can be produced in cultivation, and the investment of millions of dollars in Castilla culture in tropical Mexico and Central America may be taken as evidence that many are convinced that such production will be profitable. It is most unfortunate, however, that so many of those who have been attracted by the recent revival of interest in the subject have accepted the first view rather than the third, and have thus needlessly jeopardized their capital by attempting to grow rubber under conditions which the older experiments have shown to be more or less unfavorable.

When it is claimed that rubber culture has passed the experimental stage this should be taken to mean that the agricultural production of rubber has been demonstrated as possible. But from the agricultural standpoint it is even more true that rubber culture has only entered the experimental stage, since very little is known regarding conditions, methods, and results.

Castilla versus Hevea.—The preceding paragraphs may serve to explain why no decision has been reached on the very important question of the relative agricultural value of the different rubber-producing trees. It has been supposed thus far that the climatic and cultural requirements of the Para rubber tree (Hevea) and the Central American rubber tree (Castilla) were quite different, but the results of the present study seem to indicate that the differences, if any, have been much overestimated. The comparative experiments thus far carried on in botanical gardens have, at most, but a local value, and cannot be accepted as final. In Java, for example, both Castilla and Hevea were condemned in favor of *Ficus elastica* (Assam rubber), but it now seems probable that the continuously humid mountainous district in which the experiment was tried was quite unsuited for testing the productive powers of Castilla, and probably of Hevea also.

It may be that no one rubber-producing species will attain any great or exclusive preponderance, but that different climatic and soil conditions can best be met by planting different trees. The wisest policy in untried regions will be to make experimental plantings of all the more promising rubber trees. At present these are three in number—Castilla, Hevea, and Ficus. Manihot (Ceara rubber) can probably be omitted from the list except for regions too dry for the others.

Uncertainties Attending Rubber Culture.—Some few rubber planters have not been contented to plant anywhere that the rubber trees could be made to grow, or even where they grew wild, but have emulated the northern farmers who planted young sugar maples close by the productive parent trees. Some of the plantations of Mexico seem to be outside the natural range of Castilla, as they have found it necessary to import the seeds from other districts. Others are in localities where the rubber tree grows wild but produces little or no rubber. For example, in Soconusco it would be entirely possible to establish a rubber plantation on the lower slopes of the mountainous and humid coffee district, where wild Castilla is not uncommon. Fortunately, however, rubber planting has been confined to the warmer and drier coast plain and to localities where both wild and planted trees have been found productive. That it will become possible by correct methods to produce rubber in countries where the tree is not native, and even in localities where the wild trees do not yield well, is to be expected, but it can scarcely be repeated too often that the planting of more than experimental quantities under untried conditions is a hazardous enterprise, to say the least, and not to be indulged in except by those who can afford to lose.

In the British dependencies of the Malay peninsula, Para rubber for several years past has enjoyed an era of rapidly increasing popularity, heightened recently by the fact that some of the earlier plantings have begun to produce and that good prices have been obtained for the samples shipped to Europe. But even yet the prize of success may escape, since it appears that the new East Indian Para rubber, though received with

* From Bulletin 49 of the Bureau of Plant Industry, Department of Agriculture.

high approval by the importers, has been found seriously defective in quality.

"We have already expressed our opinion of samples of the cultivated rubber from the Malay states, which, while attractive in appearance, do not really resemble the fine Para rubber now in use. It is much softer than the Brazilian product, and of much shorter 'fiber.' It could not be used, for example, in thread, elastic bands, or any fine, pure gum goods. In solution, it quickly loses its tenacity, so that it would not do for high-grade cements. And it readily softens with age. Perhaps some of these defects might be removed by the introduction in the East of the methods of coagulation employed in the Amazon rubber camps, but we are disposed to believe that the Eastern planters have really produced a new grade of rubber, and that the Para article can never wholly be duplicated by them. It is to be understood, of course, that the rubber is valuable, and will find a ready market at a price which is likely to yield a profit, but such samples as have reached us, valued from the manufacturer's standpoint, would rank at least 25 per cent lower than fine Para.

"The good prices realized in London, doubtless, have been due to the cleanly appearance of the new rubber. And they have been based on the judgment of brokers, rather than results of practical tests in the factory. . . . The manufacturer's test is the one by which the value of this rubber will be judged finally, regardless of what may be the judgment of brokers to-day. We do not mean to dampen the enthusiasm of the planters, but there is such a thing as basing their plans upon estimates of profits that are impossible."*

It is certainly to be hoped that this disappointing report can be traced to some accident to the samples condemned, or that the quality will improve as the trees increase in age. And yet it may not be a matter of surprise that with rubber, as with so many other natural products, perfection will be found to depend on some apparently trifling and long-overlooked peculiarity of soil or climate.

But whatever the true merits or prospects of the Para rubber industry of the East Indies, the above report well illustrates the vicissitudes of hope and failure to which new cultures must remain subject until scientific knowledge and practical experience have revealed the principal factors and shown something of their relative significance.

It is impossible to tell in advance which fact will be of directly practical importance in the development of a new and complicated subject like rubber culture. Nothing should be disregarded which tends to bring the rubber-producing species into relation with the facts which have been accumulated with regard to other plants, or which can serve as a suggestion for the solution of any of the all-too-numerous problems.

Extent of the Castilla Rubber Industry.—At present the two centers of rubber culture are located in the East Indies, particularly in Ceylon and the British dependencies of the Malay Peninsula, and in Central America and southern Mexico. The India Rubber World has recently attempted a census of the rubber-planting stock companies of Mexico, and 26 of these have reported a total of 11,117 acres planted with 5,443,105 trees. The numerous companies which did not report and the many estates owned by individuals would probably bring the total area devoted to rubber to the neighborhood of 20,000 acres, or several times the space planted with Hevea in the East Indies. In the above estimate no account is taken of the numerous rubber plantations of the other Central American countries and the beginnings which have been made with Castilla in Colombia and Venezuela, which would mean an addition of several thousand acres to the estimate for Castilla.

Castilla in the West Indies.—Castilla was introduced into the botanical gardens of the British West Indian colonies shortly after it was sent to British India in 1875, but rubber culture seems not to have become established in any of them, although numerous favorable reports from Trinidad and other islands have been published.

"Castilla appears to produce good rubber and to do remarkably well in districts in Dominica where the average rainfall is about 70 inches a year. I am satisfied that the soil and climate of that island are suitable for the cultivation of rubber trees. . . .

"We find the Central American rubber tree most useful in Jamaica, and I am recommending estate owners in some districts to plant these trees along their boundaries so that, if they are not used for anything else, they will make excellent fence posts. I am also advising them to plant it in their woods, so that the seeds may be distributed by birds. . . .

"The Tobago rubber trees are grown on the cacao estates for shade purposes. On one estate the growth made by the trees was remarkable. The Central American rubber tree is the one chiefly cultivated."†

Castilla seems to have been introduced into eastern Cuba several years ago. A sample of rubber apparently of excellent quality has been received recently from Mr. Henry McManus, who states that rubber trees are growing on three estates—"Nuñez," "Palmarejo," and "La Consolacion"—in the vicinity of Baracoa. The annual rainfall in those localities is about 125 inches, and Castilla is said to thrive well.

Castilla Culture for Porto Rico.—Studies of Castilla in its native home in Mexico have resulted in a more favorable opinion regarding the prospects of Castilla in Porto Rico, since it is believed that the requirement of continuous heat and humidity has been overstated. The north and south sides of Porto Rico have very different climates; some districts of the north may be too wet and much of the south too dry for Castilla. There are, however, particularly toward the southwest corner of the island, many places where the climatic conditions are not unsuited for Castilla and where experimental plantings should be made. If the soil and other local conditions do not prove unfavorable it will be possible to utilize for rubber culture much waste land too low and too much exposed to drouth for coffee.

PROBLEMS PRESENTED BY THE LATEX, OR "MILK."

Of what use is the rubber milk to the trees, or why do the trees make rubber? These are the questions which seem to underlie the scientific investigation of the cultural production of rubber. At first it was taken for granted that the elaboration of rubber is the special function of the rubber tree, an idea apparently indorsed by some of the tree-planting companies in such statements as the following:

"You can no more grow a rubber tree without the rubber milk in it than you can grow a sugar-maple tree without the sugar sap in it. The growing of rubber trees in their own soil and climate is just as practical, just as safe, and just as sure as gathering elm seed and growing elm trees therefrom."

Rubber is not, however, the fruit of the rubber tree, except in the financial and commercial sense, and even the slightest experience in agriculture should have prevented the inference that because a plant thrives when young it is certain to reach a productive maturity. Many of the early experimenters in rubber culture have found to their cost that the Central American rubber tree, at least, can grow with the most promising vigor and yet fail to deliver any approximation of the estimated quantities of gum. Indeed, this fact might have been learned with vastly less expense of time and money by consulting the native rubber gatherers, who are thoroughly aware that many "ule" trees give no return for tapping. The realization of this simple and fundamentally important fact has been delayed through existence in some of the Central American rubber districts of a second species of Castilla, called by the natives "ule macho," or "male rubber," because it gives little or no milk.

Possibly owing to the suggestion of the obviously distinct sexes of the tropical pawpaw, or melon tree, the idea of sexuality in plants is widely prevalent among the aborigines of tropical America and their Spanish-speaking descendants, who thus have in the word "macho" a ready explanation of unproductiveness.

Perhaps it has never occurred to any of the native rubber gatherers to insist that the white man should understand the difference between the "*ule macho*," which is a distinct species (*Castilla tunu*), and the "*ule*" termed "*macho*," because it does not yield milk, though not in other respects different from the productive trees. Again has a little learning proved dangerous, in that the existence of a sterile species of Castilla has served as a general explanation of differing yields of rubber, the true causes of which still remain to be discovered.

That varietal and individual differences of yield will be found inside the genuine rubber-producing species is, of course, to be expected, but there is also every probability that conditions, whether natural or artificial, may have a profound influence on the all-important feature of rubber production, so that we are brought again to our original question of causes determining the formation of rubber.

Evolutionary Arguments Regarding Latex.—Some have insisted that the solution of the problem lies in discovering the use of the rubber to the tree, on the ground that natural selection brings into existence only useful characteristics. This theory has encouraged speculation, and numerous attempts have been made to frame a general explanation of the function of latex, or milky juice in plants. Such, however, is the diversity both of the thousands of latex-producing plants and of the substances which the various kinds of milk contain, that any explanation sufficiently general to accommodate all might have little practical bearing on rubber culture. Indeed, there is no assurance of unity of causes and methods of formation of milk in the several hundred species of rubber-producing plants of diverse families and conditions of growth, and we can even go farther and say that Castilla itself demonstrates that the production of milk and of rubber may be of no very serious importance in the plant economy, since apparently normal growth and reproduction are accomplished with little or no rubber. Furthermore, we have no assurance that the discovery of the function of the latex would bear directly upon the question of rubber production, since it does not appear that the mechanical qualities which we value in rubber, notably its elasticity and toughness, are of use to the tree or that they exist in the living latex. Commercial rubber is certainly a very different substance from the creamy mass which first appears when coagulation sets in, and numerous changes may have taken place before even this stage is reached. Between the vegetable and animal milk no complete analogy can be maintained, but it serves to illustrate the present point if we think of the rubber not as the curd which coagulates from the milk, but as the butter which may be separated both from the curd and from the still more watery constituents of the milk. As the churned butter is different, both mechanically and otherwise, from the fat globules floating in the milk, so does rubber differ, and probably to an even greater extent, from the semifluid globules of the latex emulsion. Rubber, as such, has no function in the plant, and there is nothing to indicate that the qualities which make it valuable to us are of any significance in the vegetable economy. Furthermore, it appears that at different stages of the Castilla tree, and even in different parts of the same tree, the substance which becomes rubber may be replaced by another, which hardens with exposure into a worthless, non-elastic resin; indeed, resin and not rubber is a constituent of the latex of the numerous relatives of the rubber-producing trees.* It appears, then, that to trace any direct connection between rubber and the economy of the tree is likely to be very difficult, if not

NATIVE METHOD OF TAPPING CASTILLA.

* India Rubber World, 1902.

† West Indian Bulletin, 2:112, 1901.

* In the State of Vera Cruz, Mexico, grows a large-leaved species of Ficus, the milk of which coagulates promptly into an elastic substance like true rubber, but the elasticity soon disappears when the gum is exposed to the air and repeatedly stretched between the fingers.

quite impossible, and in general reasoning on the subject the inquirer must be content to learn, if possible, the causes which influence the quality and quantity of latex in trees known to produce rubber.

Functions Ascribed to Latex.—The nature and functions of latex in plants are difficult problems. Many dissertations have been contributed to swell the experimental and controversial literature of the subject. Many interesting details have been discovered regarding many lactiferous plants, and many suggestions and theories have been contributed to the subject of plant physiology, but thus far no very practical result seems to have been reached in this direction. Indeed, progress may have been impeded by the idea that it is necessary to postpone the investigation of concrete problems of rubber production until a general theory of the function of latex or milky juice in plants can be formed. Very different suggestions regarding the uses of latex have been defended by different investigators on the basis of studies of different plants. The first observer compared them to the blood of animals and described the globules of gum as corpuscles, a highly fanciful notion which later writers have so zealously disavowed that they have felt it necessary to deny any circulation at all. Some have held that the milk tubes are reservoirs for the storage of elaborated food materials, while others believe that latex is an excretory waste product, even to the proteids, starch, and sugar with which the milky fluid is commonly charged. Protection against insects and snails has also been urged as the function of latex. One of the most recent writers on the subject* reviews and dismisses all the previous suggestions apparently for the reason that none is of general validity, and after detailing numerous observations of his own, comes to the following disappointing conclusion:

"It seems impossible to discover what is their function or to ascertain if there is one function common to all laticiferous tubes until microchemical methods are vastly improved or until analyses of latex in its various stages are made."

Obviously, however, there is no reason why it must be believed that all the functions of all milk tubes are the same, or why one function should exclude another. That insects, such as leaf-cutting ants, should not be able to attack rubber trees because the gum would disable their mouth parts might be an important advantage in Central America, but would not explain rubber in African plants not subject to the depredations of these insects. The most that can be done is to learn the uses of latex in one plant at a time, without anxiety as to whether or not a general function for latex in all plants will be discovered.

The Structure of Latex.—All the foregoing suggestions and many others seem to have been made before it occurred to anybody to treat the simple but fundamental question of how the rubber is formed in the milk-bearing tubes. But there is one author at least who has appreciated this point and who has discovered by a close microscopical examination of the rubber globules that each is surrounded by a thin coating of protoplasm, with a small nucleus on one side.† This means that the globules of rubber are produced in the same manner as globules of fat and resin, and like the granules of starch and the crystals of lime, oxalic acid, and other substances which are laid down by the protoplasm of plant cells. If the rubber appeared in the tubes merely by chemical action or because the constituent elements were brought together, this would be an indication favorable to the synthetic production of rubber in the chemical laboratory, and it would mean also that the milk is, if not a solution of rubber, at least a solution of the constituents of rubber.

There are, however, no observations to indicate that rubber exists in plants except in the form of minute globules, so that the milk resembles that of the cow in being an emulsion. The globules are not, however, naked and free, but each is surrounded by a layer of protoplasm which must contribute a part of the "albuminous constituents" of the latex, if it does not supply all, though this does not make it easier to understand the recent statement of Dr. C. O. Weber‡ that such materials are not coagulated by boiling. It might be thought that the boiling coagulates the protoplasm of each globule separately and that the rubber is released afterward and rises to the top, but Dr. Weber's statements would not bear this interpretation, though the absence of an explanation of the supposed failure of heat to coagulate any of the albuminous matter leaves the impression that this account of the details is not complete.

Seasonal Influences on Latex.—No theoretical consideration need interfere with the recognition of any relation which can be proved to exist between the amount of latex or of rubber obtainable from Castilla and the climatic conditions under which the trees are found. The most direct evidence of such climatic influence is to be found in the seasonal changes in the latex. Such difference in the rubber content of the milk at different seasons has received little attention from recent writers, though it is not a new fact, since a detailed statement was published by Collins over thirty years ago:

"In Nicaragua it is found that although the hule yields the juice at all seasons, the most favorable season is April, when the old leaves begin to fall and the new ones appear. During the rainy season, from May to September, the richness of the juice diminishes. From that time to January the rain diminishes and the milk increases in richness, and the tree prepares to flower. The fruit appears in March, during which month and the succeeding one the milk is at its richest. The yield of caoutchouc contained in an equal quantity of milk would in April be 60 per cent more than in October."§

The increased richness of the milk in the dry season seems to be recognized in all districts where the dry season is long enough to permit the effect to become appreciated but in localities where the dry weather in which tapping can be done is short there is at once less difference and less opportunity for it to become evident. Where the dry season is long, as at La Zacualpa, the flow of milk becomes small and tapping is deferred until some rain has fallen, when the quantity and quality of the milk are both at their best. The popular idea is that as the dry season advances the milk becomes too thick to flow, and that during the rainy season it becomes too poor in rubber to pay for tapping. The fact that the latex becomes richer during the dry season does not prove, of course, that the additional percentage of rubber is a measure of protection against the dry weather. It may be that the rapid growth which goes on in the rainy season uses up the rubber, while the cessation of growth in the dry season permits it to accumulate. This possibility does not, however, exclude the other, but seems rather to strengthen it, since there are other reasons for believing that the possession of latex is an advantage in the struggle against drouth. Several such facts were noticed during a recent visit to southern Mexico.

Latex in Desert Plants.—The plants able to make the most vigorous growth and put out flowers and new leaves at the end of the dry season, even in the cactus deserts about Tehuantepec, belong to the genus Jatropha and are near relatives of the Ceara rubber tree *Manihot glaziovii*. Also Prof. H. Pittier says that on the dry Pacific slope of Costa Rica the Ceara rubber tree produces rubber, but refuses to do so in the humid district of Turrialba, although it thrives well there.

In the cactus desert about San Geronimo to the northeast of Tehuantepec is another euphorbiaceous plant with naked green stems a yard or more in length and reddish unsymmetrical flowers. The stems are rich in a milky juice, which rapidly coagulates into a substance much like rubber, but lacking elasticity. The plant was quite leafless, but was blossoming at the end of the dry season. After the milky Euphorbiaceæ, the most flourishing desert plants were the Apocynaceæ, also with milky juice. The leguminous plants of the desert do not have latex, but they are noted for their richness in gums and resins, which are similarly formed and may have similar functions in the plant economy.

The most striking suggestion of the utility of latex as a protection against drouth was noticed in a cactus of the genus Mammillaria, found nestling in the crevices of the bare, black rocks of the fiercely heated hillsides about Tehuantepec. The Mammillarias differ from all other members of the family in having a thick, milky juice, which becomes very sticky between the fingers, though showing no signs of elasticity. It will be difficult to avoid the conclusion that in this instance the milky juice is the special character which has enabled the Mammillaria to excel all its relatives in resistance to desert conditions of extreme heat and dryness.

A step in the same direction seems also to have been taken by a large, straggling Opuntia found near San Geronimo. Instead of the watery juice found elsewhere in this genus, a knife cut brings out a thickish, opalescent sap, which rapidly coagulates into a somewhat resinous substance and quickly seals over the injury.

Water Storing as a Function of Latex.—As already stated, the recognition of a relation between latex and dry weather has been hindered rather than helped by the attempt at framing a theory of the use of latex to the plant; but a few writers have appreciated such facts as the above, and have been inclined to look upon the storage of water as the long-sought general function. The following extract affords an instance:

"If the formation of laticiferous tubes has been called forth in all plants possessing them to perform a common function, then I am inclined to think the idea of their serving as channels for holding water in reserve as one of the most plausible. Laticiferous plants are markedly characteristic of tropical regions, where transpiration is great. The development of a system of tubes running throughout the plant to be filled with water during the wet season and then to be gradually drawn upon during times of drouth is intelligible.

"Warming, in a paper in the Botanical Gazette for January, 1899, entitled 'Vegetation of Tropical America,' mentions lianas and other plants of tropical forest and scrub as often laticiferous, and says: 'Most likely latex serves several purposes, and one of them, I suppose, is to supply water to the leaves in time of need when transpiration becomes too profuse.'

"From our experiments in Ceylon we found that the quantity of latex extractable from incisions in the trunks of Hevea trees varied considerably with the time of the year and seemed to depend largely upon the available moisture in the soil. After heavy rain the exudation of latex is much more copious and thinner, looking as though the vessels had become surcharged with water.

"As the necessity for a reserve of water increased, the laticiferous system would tend to become more extensive and more intimately associated with the surrounding tissues. The genus Euphorbia chiefly inhabits dry regions and is one of the richest in latex.

"This view does not explain the proteid or starch grains of latex, yet I think it is one to be borne in mind in studying the rôle of latex in plants, and hitherto it has in the main been disregarded. If latex does serve as a water reserve, then perhaps it is chiefly valuable for the growing organs."*

This view has, however, met with no general acceptance, and has obvious difficulties, the most important being that the amount of water actually stored or present at one time in a tree like Castilla would not long suffice for necessary transpiration. It avails little for such a plant to store unless it is also possible to husband the supply. At present however, there seems to be no practical suggestion of means by which latex rich in rubber could better assist either in storing the water or in preventing transpiration, but of these alternatives the facts seem to be much more in favor of the latter. Apart from the slight increase due to growth, the contents of the trunk must remain of approximately the same volume. The increased pressure to which is due the increased flow of milk after the rains begin does not require a large increase of the volume of liquid in the tree, and is in all probability greatly assisted by its greater fluidity, which enables it to flow longer distances to the cuts, the capillary friction being decreased. The greater humidity of the atmosphere would also tend to the continuation of the flow in the rainy season by preventing the drying or the coagulating of the surface of the cuts, though the importance of this factor has not been determined.

That the increase of the rubber content of the latex serves as a protection against drouth is also rendered somewhat more probable by the fact that Castilla has several characters serving the same purpose. The development of hairs upon the branches, bud scales, leaves, flowers, and fruits is much greater than is usual among related plants. The self-pruning of the branches and the rapid covering of the scars are also exceptional and of obvious utility in reducing transpiration, and the prompt falling of the leaves in situations where the water supply becomes deficient shows even better the sensitiveness of Castilla to drouth.

Significance of Multiple Tapping.—The latex problem acquires new interest from the recent demonstration that Hevea, at least, continues not only to yield milk by the daily renewal of the wounds, but that the quantity actually increases for several days. This might seem to favor the idea that the latex has a nutritive function, the additional quantities being assembled, as it were, to repair the injury. On the other hand, the supposition that the rubber hinders evaporation would work equally well and affords the additional suggestion that the greater evaporation from the wound may assist in collecting the rubber about it, the yield increasing as the widening of the wound increases the surface of evaporation until the available supply of latex has been depleted.

EXTRACTION OF THE LATEX OF CASTILLA.

Scarcely second in practical importance to a solution of cultural problems is the attainment of satisfactory methods of tapping. The object is not merely to avoid the destruction of the trees, but to learn how the maximum quantity of rubber may be secured with the least injury to future productiveness. The planter needs to know how soon young rubber trees should be tapped, how the incisions should be made, how close together, how large, and in what direction; how often tapping may be repeated, at what seasons, and much more.

The first notion of the visitor from the United States is that it will be a very simple matter to improve on the rude gashes made by the machete of the rubber gatherer, but this has not proved to be easy. The rubber milk is not the sap of the tree and cannot be drawn out by boring holes in the trunk, as is done with the sugar maple. The milk does not pervade the tissues of the tree, but is contained in delicate tubes running lengthwise in the inner layers of the bark, and to secure milk in any quantity it is necessary to open many of these tubes by wounding the bark. The rubber is formed in floating globules inside the tubes and cannot pass through their walls, so that even a suction apparatus would not bring it out unless the tubes were cut.

Primitive Methods of Tapping.—The method by which the natives of Soconusco have been accustomed to extract the milk is shown in one of the illustrations. The ulero makes with his machete diagonal lines of gashes that open channels along which the milk can flow until it is all brought to one side of the tree, whence it is led down to a cavity hollowed in the ground and lined with the tough leaves of Calathæa. These are dexterously lifted up, and the milk is poured into a calabash or other vessel and carried away to be coagulated. The diagonal channels are from 2 to 3 feet apart, and those of each successive tapping are inserted between the older scars. The diagonal lines are carried well around the tree; to tap it on the other side requires much deeper cuts in order to pass the milk across the older grooves, down which it would otherwise run and be lost. That the trees at La Zacualpa had been able to survive so much of this barbarous treatment and were still vigorous and heavily laden with fruit seems to indicate great tenacity of life. And yet even this rough handling represents an improvement upon the former custom of cutting the trees down entirely or hewing steps in them for the ulero to climb up. Instead of the forked stick used as a ladder at La Zacualpa the large forest trees were ascended for 30 feet or more by means of ropes, vines, climbing irons, and steps cut in the trunk. The following is a description of a method of tapping trees in the forests of Nicaragua:

"When the collectors find an untapped tree in the forest they first make a ladder out of the lianas or 'vejucos' that hang from every tree. This they do by tying short pieces of wood across them with small lianas, many of which are as tough as cord. They then proceed to score the bark with cuts which extend nearly around the tree, like the letter V, the point being downward. A cut like this is made about every 3 feet all the way up the trunk. The milk will all run out of the tree in about an hour after it is cut, and it is collected into a large tin bottle made flat on one side and furnished with straps to fasten onto a man's back. A decoction is made from a liana (*Calonyction speciosum*), and this, on being added to the milk in the proportion of 1 pint to the gallon, coagulates it to rubber, which is made into round, flat cakes. A large tree, 5 feet in diameter, will yield, when first cut, about 20 gallons of milk, each gallon of which makes $2\frac{1}{2}$ pounds of rubber. I was told that the tree recovers from the wounds and may be cut again after the lapse of a few months; but several I saw were killed through the large harlequin beetle (*Acrocinus longimanus*) laying its eggs in the cuts, and the grubs that are hatched boring great holes all through the trunk. When these grubs are at work you can hear their rasping by standing at the bottom of the tree, and the wood dust thrown out of their burrows accumulates in heaps on the ground below."*

(To be continued.)

"Big Joe" Grimes, who was reputed to be the largest man in the world, died September 4 at the home of his parents in Ohio Avenue, Cincinnati. He was 34 years old, 6 feet 4 inches tall, and weighed 754 pounds. Grimes's death was the result of a peculiar accident. While riding in a cab his great weight broke the bottom and one of his legs was gashed. The wound would not heal.

* Percy Groom on the Function of Laticiferous Tubes, Annals of Botany, 3: 157, 1889.

† Studien über den Milchsaft und Schleimsaft der Pflanzen, von Prof. Dr. Hans Molisch. Jena, 1901.

‡ Tropical Agriculturist, 22:443, January, 1903.

§ Report on the Caoutchouc of Commerce, 1872, p. 15.

* Parkin, Ann. Bot., 14:212-213, 1900.

* "The Naturalist in Nicaragua," Thomas Belt, F.G.S., pp. 33-34. The liana called by Belt *Calonyction speciosum* is generally called *Ipomoea bona-nox*.

INFECTIOUS AND CONTAGIOUS DISEASES OF FARM ANIMALS AND THEIR EFFECT ON AMERICAN AGRICULTURE.*

By D. E. SALMON, D.V.M., Chief of the U. S. Bureau of Animal Industry, Washington, D. C.

THE subject which I have been asked to discuss at this congress is a very large one, and includes so many different elements that it can only be treated in the most general manner in the short time at my disposal. The omission of many important details is, therefore, a matter of necessity rather than choice. What I shall hope to do is to impress upon you the necessity of controlling the contagious diseases of farm animals, and the practical value to the farmers and to the country at large of the efforts of the federal government which are being put forth to investigate, to understand, and to control these diseases.

Animal husbandry is one of the most important branches of agriculture, and it has been developed in the United States to a degree which excites the admiration of the world, and which justifies every legitimate effort for its assistance and protection. In no other country can you find such an aggregation of farm animals—animals in such amazing numbers, of such value, so highly bred, and so free from disease. Statisticians tell us that we have more than 19 millions of horses and mules, over 17 millions of milch cows, 44½ millions of other cattle, nearly 64 millions of sheep, 47 millions of swine, and 250 millions of fowls of various kinds. The horses and mules are worth 1,200 millions of dollars; the cattle are worth 1,300 millions of dollars; the sheep are worth 168 millions of dollars; the swine are worth 365 millions of dollars; the fowls are worth about 86 millions of dollars. In round numbers, the total value of these farm animals is 3,119 millions of dollars.

This, then, is the tremendous investment of capital which our farmers are holding in domesticated animals. It is generally regarded as simply representing so much wealth, and as a matter of interest to no one but the owners. But we must take a broader view than that of our animal husbandry. The cattle, sheep, swine, and poultry are a large and essential part of the food-supply of the nation, and the horses are necessary for the production of the other part of our food-supply. Any cause which reduces the quantity of our food-supply or increases the cost of its production makes the conditions of life, especially in the large cities, more difficult, adds to the distress and misery of that part of the population which at best is merely able to exist, and tends to increase disease and mortality in proportion as its effects are felt. There are, also, times when through domestic disorder or foreign foes the very life of a nation is at stake, and in such emergencies the food-supply has often been an important factor in its preservation. And one of the conditions which undoubtedly adds to the stability of our government is the abundance and the high quality of the food-supply produced by American farmers.

These considerations apply, of course, to all the elements of the food-supply as well as to the domesticated animals, but they are of especial interest in connection with animals because of the imported plagues which are generally preventable but which often sweep a continent as with fire, depleting the supply of animal food, endangering the public health, and ruining many people who are engaged in agricultural pursuits. A calamity of this kind affects nearly the whole population of a country, depresses business, causes restrictions upon traffic, and often leads to the closing of foreign markets for the animals and animal products of the affected country.

The losses from communicable animal diseases in the United States, considering the large numbers of animals produced, have been moderate as compared with other countries, the distance from the Old World having for the most part protected us from the plagues which are most destructive there. Still, we have had troubles of our own, and some of them very serious ones; and it is to the consideration of these that most of my time is devoted.

THE CONTAGIOUS PLEURO-PNEUMONIA OF CATTLE.

An imported disease known as the contagious pleuro-pneumonia of cattle led to the establishment of the United States Bureau of Animal Industry and to the active interest which the federal government has since shown in the protection of our farm animals from the ravages of communicable diseases. This plague was allowed to slumber in the eastern part of the country for forty years before active measures were inaugurated by the general government for its suppression. Fortunately, the current of traffic was from the West to the East, or the contagion would have been spread beyond the possibility of eradication. Nevertheless, diseased cattle were taken to the West, and the plague appeared in Ohio, Illinois, Missouri, and Kentucky, threatening the entire cattle industry of the country. In this precarious and dangerous situation, when the integrity and the prosperity of the cattle industry for many years in the future, if not for all time, hung in the balance, we had divided counsels. Men who had never seen the disease, for the good reason that they had never looked for it in the places where it prevailed, insisted that it did not exist upon the American continent; others urged impracticable plans for its eradication; and there were not wanting those who claimed that the effort for the control of the disease was simply a raid on the treasury, and that the disease would last as long as appropriations were made.

Under these apparently discouraging conditions an inadequate appropriation was made, with no direct authority to go into the States where the disease existed and enforce the measures necessary to combat it. However, the best that could be done under the circumstances was done; the contagion was held in check, and evidence of its existence was produced. To be brief, the funds were soon increased, more power was given, and within five years from the beginning of the work the contagion was totally stamped out; and although a dozen years have since gone by, the disease has not again been found on this continent. There still remains, however, an unpleasant reminder of the fact that it once existed here. In 1879, the British government, on the ground of the existence of this disease in the United States, prohibited our exported animals from going inland to market, and required them to be killed on the docks where landed. That regulation is still in force; and with the oft-demonstrated disinclination of the British officials to treat our cattle trade with justice (we have never asked for generosity), it would appear that there is little likelihood of its being removed, at least during the lifetime of the present generation. The effect of this regulation is not as injurious to-day as it was a quarter of a century ago, when first instituted. Then, it depreciated our cattle from five to ten dollars a head; but the trade has since adjusted itself to the existing conditions, and now the loss on this account is comparatively light.

The results which followed this pleuro-pneumonia work were of incalculable benefit to the agriculture of the United States. In the first place, the celerity with which the disease was eradicated here was an object lesson to the whole world. Great Britain, Germany, France, and other European countries had for many years been enforcing measures in a half-hearted manner for its suppression, without success, and for a long time they were incredulous that we had succeeded. An abundance of time has now elapsed for a complete demonstration, and this has given our government a reputation for intelligence and efficiency in the control of animal diseases which has been of considerable assistance in preventing restrictions and prohibitions being placed upon our animals and animal products in various parts of the world. Great Britain has also followed our example and stamped out the disease, thus relieving us of the menace of its reintroduction with British cattle.

The most important result of the pleuro-pneumonia work, however, was probably the establishment of a bureau, in the national Department of Agriculture, to investigate and furnish information concerning the animal industry of the country, and to perform such executive work in relation to animals and animal products as may from time to time be necessary or desirable. The inspection of meats for interstate and foreign commerce was inaugurated immediately after the termination of the pleuro-pneumonia work, and this, together with the scientific investigation of disease, enabled us to collect and maintain a force of trained experts who were available for immediate service in an emergency such as we have had in New England during the past year.

The eradication of pleuro-pneumonia has also been an object lesson of the greatest value for our own farmers. It has proved to them that notwithstanding our peculiar form of government and the rights of the sovereign States, it is possible for the federal government to eradicate animal diseases in this country. It has also proved that certain plagues of animals are of exclusively exotic origin, and that if the contagion is once thoroughly stamped out those diseases will not again be seen until fresh contagion is introduced from abroad. This is a lesson which we all need to have forced upon us again and again before we can appreciate the great importance and the permanent value of prompt and efficient work in stamping out such plagues. It is not difficult for any one to understand that if all the zebras, for example, on the American continent were killed off, there would never be any more here until there had been another importation of these animals; but when it concerns the infinitely small forms of life which constitute the contagion of the animal plagues, it requires actual experience with them before we can fully realize that the same principle holds good with them as with the larger species of animal and vegetable life.

FOOT-AND-MOUTH DISEASE.

Late in November of last year the country was astounded to learn that an extensive outbreak of foot-and-mouth disease existed in the New England States. We had for years maintained a rigid quarantine of all susceptible animals coming from countries where the disease existed; we had taken special precautions to insure so far as possible the disinfection of hides from infected countries; we had held up, inspected and in some cases quarantined menagerie animals; we had been particularly careful to prohibit or disinfect halters, feed bags, hay, and bedding that came with animals from infected countries. The entrance of the contagion was therefore a mystery, and one which has not yet been satisfactorily cleared up. What we know is that the disease was first seen near the docks, and spread from there toward the interior. There are, of course, many ways in which the contagion might be brought and escape our inspectors, but it does not often come through such channels, as is proved by the fact that this is the first outbreak of the disease that we have had in twenty years, and the only one that we have ever had that could not be traced to the importation of diseased cattle.

When I arrived in Boston, December first, more than one hundred herds of diseased cattle had already been discovered in Massachusetts, Rhode Island, and Vermont. The local quarantine was largely disregarded, and people going from one stable to another carried the contagion and extended the infected area. Cattle dealers were gathering up animals in the infected sections and shipping them to market; in some cases they sent them to other States. Cars were thus infected, with imminent danger of their carrying the disease to the interior of the country. Newly-diseased herds were reported daily. In this emergency it was necessary to stop the exportation of cattle and sheep from Boston; it was also necessary to quarantine the States in which the disease existed, and to prevent cattle, sheep, swine, and undisinfected railroad cars from going to other States. After duly considering the practical impossibility of maintaining an efficient quarantine of the diseased herds, and the failure of other countries which had endeavored to control such outbreaks by quarantine, it was decided to kill at once all susceptible animals upon the premises where the disease was found.

This plan was carried out, and the only exceptions made were in the case of herds which had gone through the disease and entirely recovered before they could be reached. Before the work had progressed very far, it was found that the disease also existed in New Hampshire, and had been quite extensively disseminated in that State. The same regulations were applied there as in the other infected States. As soon as possible after the herds were killed, the barns, stables, and yards were disinfected by trained men and at government expense. In some cases the hay, straw, and other fodder were purchased and burned. As a result of this thorough work, the disease was stamped out, and no new territory was infected after the government force was organized and put into the field.

The measures adopted to suppress this outbreak were looked upon by some citizens as extremely arbitrary and harsh, and the Department of Agriculture has even been censured for securing the prosecution and conviction of men who deliberately violated the quarantine and drove cattle out of the infected States for the purpose of shipping them to the general markets of the country. But suppose the disease had been spread in this manner, and new outbreaks had appeared in other States; would not the Department have been even more severely censured for failing to control the contagion? There appears to be a tendency to look upon laws and regulations as things which are made to be violated, and if this tendency were encouraged, it would be impossible to stamp out such plagues as foot-and-mouth disease. Undoubtedly, the best policy is to make only such regulations as are absolutely required, to keep these in effect only for the time that is necessary, and to enforce them with the utmost rigidity. This policy hastens the progress of the work, it lessens the burden of the great mass of citizens, and it gives a greater assurance of success. In carrying out this policy in New England the Department had the support of a majority of the people, and especially of the farmers, although there was much opposition in a few of the badly infected localities. The co-operation of the State government was secured in every case, and was of inestimable value in hastening the operations and in securing success.

Foot-and-mouth disease is said to cause more loss in Europe than all the other animal plagues combined, and yet there is generally so small a proportion of deaths from it that it is sometimes hard to convince the owners of affected cattle of its serious nature. Different outbreaks show great variations in virulence, and in the same outbreak the disease may be severe in one locality and mild in another. Practically all cattle, old and young, sooner or later contract the disease, and the sheep, hogs, and poultry may also be affected. Averaging up the losses, we may assume that about five per cent of the cattle die; the remainder, through loss of flesh, loss of milk, abscesses in the udders, and lameness shrink 25 per cent in value. Many of the calves are lost. Sheep and swine are stunted in growth, lose flesh, and many of the young die either directly from the disease or from complications which follow it. Sheep on ranges, where the losses from inclement weather are always considerable, are so weakened by foot-and-mouth disease that the winter losses are greatly increased.

Taking all the facts which have been mentioned into consideration, we may conclude that the extension of foot-and-mouth disease over the United States would cause our farmers a direct loss of about 400 millions of dollars. This loss would occur in the course of three or four years; but we have no assurance that the disease would disappear at the end of that time. On the contrary, the contagion might persist here, as it has in Europe during the last outbreak, for fifteen or twenty years, causing continual loss and stunting of the young stock, shrinkage of flesh in all classes of animals, with especially severe loss and interruption to the dairy business. The loss, during this period of recurrence might be conservatively placed at 50 million dollars a year. The total loss to our farmers from such an outbreak would, therefore, be not far from a thousand millions of dollars. But there are other losses which must also be considered. We saw last winter how soon Great Britain prohibited the importation of animals from the New England ports. This affected only the transportation companies and the ports directly concerned; but, if we had a general outbreak of the disease, animals from all our ports would be prohibited. The foreign market would be destroyed, the price of animals would be unfavorably affected, and there would be inconvenient and burdensome restrictions upon traffic in every State. This would be a most serious calamity, and one which should be averted at any reasonable cost.

RINDERPEST.

The rinderpest or cattle plague of Asia and Europe has never appeared on American soil, but it is liable to be brought here at any time, and we must be on our guard against it. This disease spreads as easily as foot-and-mouth disease, and it kills within a few days 90 to 95 per cent of the cattle. Recently, methods of vaccination have been practised by which the loss may be reduced to about 30 per cent. Under the best conditions, however, it is a disease to be feared and avoided by every means in our power.

The increase in transportation facilities and the greater speed of steamships increase the chances of the introduction of such diseases into our country. Every day that is cut off the voyage between the Old World and the New, brings the source of these diseases one day nearer to the United States, and makes greater precautions necessary. With foot-and-mouth disease in Europe and South America, and with rinderpest in the Philippines, in South Africa, in Egypt, and in Asia, we have to face danger in many directions. We cannot in this age of the world adopt a policy of absolute non-intercourse with other countries, and consequently we must incur some danger of meeting with one of these terrible calamities which bring financial loss almost equal to a great war.

INDIGENOUS DISEASES.

We have so far discussed exotic forms of diseases, those which are not domiciled among us, and which must be fought by exclusion or by the most rigid stamping-out process whenever they enter our domain. In addition to these we have diseases which, whatever their original source may have been, are now widely disseminated, and must be looked upon as indigenous.

* Read at the Farmers' National Congress, Niagara Falls, N. Y., September 26, 1903.

Such diseases require different treatment from the exotic plagues. It may without doubt be good policy to kill off all the affected animals in a restricted area to prevent the spread of contagion to other parts of the country; but if the contagion has already been scattered to all sections of the country, this measure is obviously impossible, and other means of control must be devised. The character of such measures will depend somewhat upon the nature of the individual disease to be controlled and upon other existing conditions.

(To be continued.)

THE WHOOPING CRANE.

THE great whooping crane (*Grus americana*) of our western territories is in many ways a noteworthy bird. It is a striking member of its family, both on account of the character of its plumage and of its size. The bird is about four feet high, and is well pictured in the accompanying illustration, taken from the United States National Museum's recent report.

THE WHOOPING CRANE.

COLORATION OF THE QUAGGA AND REASONS THEREFOR.

IN writing to Nature on the coloration of the quaggas, R. I. Pocock says that Grant's quagga, which is found in northeastern Africa, may claim to rank as one of the most completely striped of existing horses. Apart from the ears, which are sometimes nearly white, and the muzzle and fetlock, which are usually black, he is a mass of stripes from head to tail, from hoof to spine; and in sharpness of contrast between the blackness of the stripes and the whiteness of the interspaces, he rivals the Abyssinian race of Grévy's zebra and Angolan race of the mountain species, while surpassing both in the inferior extension of the stripes to the middle line of the belly. Compared with Gray's quagga, it seems impossible to believe them of the same species, although such is the case. Mr. Pocock says the chief interest in those intermediate between the two specimens named lies in the progressiveness of the change this species undergoes as it passes from north to south over its geographical area. Even in British and German East Africa the pale interspaces on Grant's quagga begin to be washed with brown, and to be filled in with narrower intervening stripes, which may be taken as the first step in the change from Grant's to Gray's quagga. From this step may be traced a series of gradations represented by the local races in which the stripes gradually disappear and thin out upward from the fetlocks to the shoulders and haunches, while those on the body lose their connection with the mid-ventral band, and, becoming shorter, leave the belly unstriped. Concomitantly, the intervening "shadow" stripes increase in number and definition as they extend forward toward the neck, the normal stripes themselves turn brown, and the ocher-stained ground color deepens in hue. In the typical form of Burchell's quagga, far south in Africa, the "shadow" stripes reach the head; and the last of the complete stripes is the one which extends back from the stifle to the root of the tail, the hindquarters and legs being practically, and the belly actually, stripeless. It is but a step from this to the extinct Gray's quagga, still further south, in which the stripes of the body were fused together and blended to a great extent with the brown of the intervening areas, those on the neck being exceedingly broad and broken up by paler traces of hair.

"The tendency of these modifications," says Mr. Pocock, "is to convert a striped and conspicuously particolored animal into one which, even at a short distance, must have appeared to be an almost uniform brown, paling into cream on the underside, limbs, and back of the haunches. What is the meaning of this change? Inferentially we may conclude it was protective in the sense of subserving concealment. The testimony of observers in the field has established the truth that the coloration of the coat renders a zebra invisible under these conditions, namely, at a distance on the open plain at midday, in close quarters in the dusk on moonlit nights, and in the cover afforded by thickets. The latter result is due to the co-operation of several factors. The white stripes blend with the shafts of light sifted through the foliage and branches and reflected by the leaves of the trees, and in an uncertain light or at long range they mutually counteract each other, and fuse to a uniform gray. It is probable, too, that the alternate arrangement of the black and white bars contributes something to the effect produced, by imparting a blurred appearance to the body and destroying the evenness of its surface owing to the difference in light-reflecting power between hairs of these hues, to which domestic horses bear witness. Moreover, the extension of the stripes to the very edge of the body and legs breaks up the continuity of the outline, and this, I believe, is the reason for the alteration in their direction on the hindquarters and limbs, so that, except on the forehead, the whole animal is barred transversely with reference to its spinal and appendicular axes.

"We have also the positive assurance of observers that the asses of the deserts of northeast Africa are perfectly adapted to their surroundings in color, and no one can doubt that the assimilation is equally perfect in the case of the kiang and Prjevalsky's ponies of Central Asia. In the matter of coloring the kiang forcibly recalls the typical quagga, despite a decided difference in the deepness of the brown pervading the upper parts in the two species. Notwithstanding this difference, there can, I think, be no question that the explanation to be given of the significance of the colors of the kiang applies with equal truth to the quagga. This explanation is the hypothesis of the counteraction of light and shade put forward by the American artist, Thayer.

"It would be hard to find a better and simpler instance of this style of coloration than the kiang. The upper parts on which the light falls are of a rich ruddy hue, darker than ordinary sand, while the muzzle, the lower side of the head, the throat, and the belly are creamy white. Surely no one with a knowledge of the truth enunciated by Thayer will dispute that the arrangement and nature of the colors in the kiang must render it practically invisible when standing in the desert at a distance. But this is not all. Why are the legs, or at least the greater part of them, and the back of the thighs up to the root of the tail also white? This is doubtless the reason: When the kiang rests on the ground in the attitude characteristic of ungulates, with the hindquarters depressed, the fore legs folded, and the hind legs tucked in close to the body, the white on the back of the thighs is brought into line with that of the belly, and a continuous expanse of white, obliterating the shadow, extends all along the underside from the knee to the root of the tail. So, too, with the quagga. This, then, is the meaning of the change in pattern presented by the African species as it passed southward into Cape Colony. In correlation with the adoption of a life in the open, a new method of concealment by means of shadow counteraction was required, and was gradually perfected by the toning down of the stripes on the upper side and the suppression of those on the hindquarters, belly, and legs."

PONDS AND SWAMPS.

A POND, particularly if a portion of the margin is swampy, has great possibilities for the nature student. There seems to be no limit to the variety of living creatures which he may find there in the course of a year. In this respect a pond is superior even to a brook.

I live near such a pond, and I visit it often. It has its counterpart in any one of ten thousand little ponds throughout the country, yet the United States government does not employ a number of clerks sufficient to record the business which is transacted within sight of its banks. No matter how hot or how cold the weather; no matter how dull things are in the country round about—here there is always something interesting to be seen or heard. Here I come in the early spring, to see the first, and seemingly the brightest, of the marsh marigolds, reflected in the cold, clear water, and to lift from the shallows masses of transparent frog spawn, in which may be seen scores of tiny black specks, which some day will be frogs. Here, too, I come at night to hear the lonely bittern calling his mate in a voice which sounds like water beating against the mouth of a cavern. And later in the year I find their nest in the marsh near by, a handful of coarse grasses, with four or five buff eggs. And so all through the summer, when the turtles sit in rows on the half-sunken logs and when the frogs squat upon the lily pads, until the fall, when the muskrats build their winter houses on the mud flats, and when the black ducks and the wild geese drop in to spend a few days on their way to the south. Nor is business suspended in the winter, for then under the shelving ice along the bank, I mark the tracks of the mink, and when I see between them the tiny footprints of mice, I know pretty well what he was looking for.

Among the other inhabitants of this pond are some huge snapping turtles, whose age is the subject of frequent discussions at the nearest country grocery. Some bear upon their shells certain dates and other marks, which, it is claimed, were carved more than fifty years ago. It is not often they are seen, but now and then one of these old villains will raise his great snake-like head above the surface of the pond, and blink a pair of the coldest, cruelest eyes which ever disfigured the head of a reptile. Nothing in the pond is sacred to these hardened old sinners. No doubt they live largely on fish, but young muskrats and ducklings are often jerked below the surface of the pond to rise no more, and wild mice, which sometimes swim across, are foolhardy to say the least. Last June I was walking along the bank of a little stream which flows through a meadow and into a pond, when my attention was attracted by the peculiar movement of a patch of waving grass. It was easy to see that the wind had little to do with it, so I ran over to investigate. In the middle of a good-sized depression caused by the flattening down of the grass, stood a giant snapping turtle, weighing fifty pounds if an ounce, I should say, and with great horny jaws agape, ready for business. I guessed that it was probably a female on her way to deposit her eggs in the sand somewhere, so I decided not to interrupt her. Instead, I retired to a distance, and climbed a tree, whence I had a good view of the meadow and the surrounding country. The old lady snapper continued on her way, lurching through the grass like a tramp steamer in a heavy sea, and stopping now and then to raise her head and look around. In the course of time she came out of the meadow and into an old road with a sandbank running along one side of it. This bank seemed to be her destination for on the side of it she halted, and began scraping a hole with her big, beclawed front feet. She seemed to be in no particular hurry, and as I was, I slipped down the tree and left her to take her own time. By and by I returned, and there she was still scratching in the bank. But this time she was raking the sand into the hole, and the task was nearly done. I waited until she had completed the work, and as soon as she waddled away, I began to do some digging myself. Under some twelve inches of sand I came upon the eggs, twenty-two of them, pure white and as round as marbles. In fact they looked more like large white alleys than anything else I know of. I covered them up again, and if they are not discovered by a skunk or some other animal which is fond of such dainties, they will probably hatch some time late in the fall.—Ernest Harold Baynes, in Evening Post.

FISH HOOKS OF MANY KINDS.

AT a recent meeting of the Anglers' Association of Onondaga, George Barnes Wood, of Syracuse, read a paper on "Fish Hooks." Among other things he said:

Primeval man hooked and caught fish by the aid of numerous devices, the most important of which were gorges made of bronze or stone. The latter consisted of pieces of stone about an inch in length with a groove in the middle for a line. One of these gorges, a relic of the Stone Age, has been discovered in France and is about eight thousand years old. When swallowed by the fish, it turned across the fish's gullet and held it secure.

After stone, bronze was used, and then bone. Th

early Indians used bone, thorns and antlers, and later improvised hooks made from hand forged nails.

The saying of Amos in the Old Testament established the fact that fish hooks have been used nearly 2,700 years. He says, "The days shall come upon you, that he will take you away with hooks, and your posterity with fish hooks." (Amos iv., 2.)

It has been stated that the best quality of hooks are made in this country and that the imported hooks are inferior in temper and durability. The facts are simply reversed. There has been but one factory in the United States that ever made the attempt to compete with the imported hooks, and it gained a fine reputation for turning out hooks which were compared to pin hooks, with the exception of their having a barb.

The reason why Americans do not manufacture as good hooks as those imported is the same as why we cannot make needles. We lack the experience in tempering, and, until recent years, have been unable to make steel to compare with that of England, Germany, and France.

There are over two hundred different sorts of hooks, each having from twenty to thirty sizes, among which may be mentioned:

Eyed, Flatted, Ringed, Tapered, Turndown eye, Knobbed, Spiral eye, Kirby, Limerick, Kendall, Sneck bent, Pennell turndown eye, Cholmondeley Pennell, Gravitation cod, Double brazed, Double black or japanned, Double brazed live bait, Lip hooks, Mansen treble, Double reversed Limerick, Round bent sea hooks, Harwich sea hooks, Exeter, Shark, Carlisle, Cincinnati bass, New York bass, New York trout, Perfect trout, Perfect bass, Halibut, Mackerel, Dog, Roach, Hake, Mackensie, Baiting hook, Central draught, Indiana bass, Kensey, Blackfish, Sheepshead, Whiting, Virginia, Chestertown, O'Shaughnessy, Aberdeen, Sproat, Bayonet point, Spear point, Hollow point, Needle point, Double, Treble, Quadruple, Double safety pin, Norway, Yankee, Pothook, Weedless, Sockdolager, Automatic, Round bend, Pennsylvania, Salmon, Crystal.

Yankee inventions on fish hooks have been numerous, but little attention has been given to efforts to change the shape. I have examined the United States Patent Office reports and find 119 patents were granted on fish hooks from the year 1872 to 1903, an average of about four each year. The banner year was in 1899, their being fourteen patents issued. Nearly all patents have been on the principle of the "snap-and-catch-'em" order, none of which appeals to the true angler.

The Kirby is the oldest steel hook made in England. Its name is derived from its inventor, a Mr. Kirby, of London. Samuel Allcock, of Redditch, England, writes me that he remembers the appearance of the Kirby hook sixty-five years ago. This hook has a curve in the body, is commonly called a bent hook and does not lie flat on a level surface.

The Limerick follows next in order. It is a straight hook and lies flat on the level. The bend is more acute and the barb a trifle longer than on the Kirby hook. It was made in Limerick, Ireland; hence its name.

Shortly after it came out, a Mr. Philips, of Dublin, Ireland, made a slight alteration of the point. Instead of a straight point, he caused the point to stand out; he also made it not quite so long, hence the name "Dublin Limerick." His claim was that upon striking the fish it was more sure of hooking him.

The Kendall hook was first made in Kendall, England, whence its name. It has an almost square bottom and is bent like the Kirby, the shank being about the same length.

Carlisle hooks were first made at Carlisle, England. They have a round bend and lie flat. Later they were manufactured at Kirby and given a bend and were termed "Carlisle Kirby," which shape is mostly used in this country and called Carlisle.

Barbless hooks have been used by the Japanese for centuries. They are much used by fish breeders in order to avoid injuring the fish when taken from the water to be stripped of spawn and milt for the hatchery.

When Seth Green was in charge of the New York State Fish Hatchery at Caledonia, he made the assertion that more fish could be caught and saved by barbless hooks than any other. He gave me a few to try and taught me how to make them, which was by using the best steel needles. First we annealed them and then bent them around a form which was like a Carlisle, only the point was a trifle higher.

I made over one hundred, which were distributed among my angling friends as an experiment. The results were the same. On small trout, which could be quickly landed, it worked admirably, but for bass, pike, and pickerel it was a failure, as the reports showed a loss of six per cent of fish hooked.

H. Cholmondeley-Pennell, of London, was formerly Inspector of Sea Fisheries of England. The eyed trout hook was perfected by him in 1885, and, strange to say, it is almost a new hook to the angling fraternity in the United States.

It is used extensively in England, especially for flies, as they are much easier to carry and with little practice are quickly changed from one kind to another on the leader. I consider the draft better than any other kind. The Limerick style combines the three great requisites of penetration, holding power, and flotation, or the general contour of the shank.

Double hooks originated centuries ago. They are said to have been used before the single hook. Many millions of double hooks are now utilized in this country for the manufacture of spoon baits, gangs, and inventions to represent fish.

More than a century has passed since any attempt has been made to improve the eye. One manufacturer has lately been granted a patent on double interchangeable hooks. The shank is arranged like a safety pin. Its advantages are: It can be attached and detached in a second; it can be made in single or treble hook as well.

The sproat hook is undoubtedly one of the best known and most universally used hooks throughout the United States. It has been termed by some the hogback, as it has that appearance when laid on its point.

It has gained a world-wide reputation on account of its admirable form, having a beautiful curve, and its penetrating power is very near correct because the point is nearly in the direction of the point. It also has the advantage of being less liable to break than any other on account of its general construction, together with the size of the wire used.

The wire used in hook making is the best English cast steel, which must be first quality—otherwise it will not temper properly—the gage or size varying according to the requirements of the hook to be made.

First—The operator takes a part of a coil of wire in his hand and places the ends in a gage, and the correct length being arrived at, he quickly and sharply cuts them into lengths with a large pair of shears.

Second—Bearding. A number of wires thus prepared are arranged on a plane surface, with their right-hand ends against an upright. The barb, or beard, is then cut by means of a hollow-ground knife which, being pressed forward and deftly turned by the hand of the workman, opens the barb to the required angle, great care having to be exercised in this operation to avoid cutting too deep or opening too wide, or the barb breaks when used.

Third—Filing. The points are now carefully filed. Using a pair of tongs made specially to hold the wire and rapidly turning the same a point is filed on instantly, forming either what is termed a hollow, Kirby, or Dublin point. All best hooks are filed this way by hand, thus giving to the point three or four knifelike cutting edges, enabling it to penetrate much more quickly than the less expensive needle pointed hook.

Fourth—Bending. It is now necessary to give the hook its form, and for this purpose the workman holds a mold fashioned like the pot hook of our copybooks, mounted on a wooden handle. With one deft movement the beard is hooked around the shorter end, and a quick turn brings the shank straight with the shank of the mold.

Fifth—By the aid of an ingenious machine, or hammer, the end of the shank is either ringed, flatted or marked. If intended for salmon or trout flies it is filed to a delicate point, or knobbed.

Sixth—Process six is most important, and is that of the hardening of the hitherto soft steel hook. This is carried on in a specially constructed building, and consists in placing the hooks in a white-heat furnace, watched by an experienced workman, who withdraws them on seeing them attain a certain appearance, and plunges them into a vat of oil. This converts the temper of the hitherto soft hook into a highly brittle condition. Mere description cannot do justice to this stage of hook manufacture.

Seventh—Tempering. The hooks are then taken from the oil, mixed with heated sand, and placed in an iron pan over a fire, sand and hooks being kept in constant motion. Ever and anon, a hook is picked out and tested, and as soon as one lot is deemed sufficiently tempered it is passed to one side and another takes its place.

Of course, the experience of the operator dictates the finish of each parcel, and the man is always selected from those of the highest capabilities. The heat required for each size and style of hook varies, and there is all the difference between a hook too hard or too soft.

In the former case, immediately it is struck against the hard jaw of a fish it breaks, either going at the bend or at the point. Nothing is more irritating to the fisherman than to find the fish pricked and gone, and the point also minus, and this not discovered possibly till he has hit, and, as he thinks, by some fault of his own, missed the rising fish.

The best hooks are those which are tested and found of perfect temper and they are, of course, of the best price. Those which, by some mistake or accident or unavoidable chance, are not deemed A1 are placed on one side and sold at a considerable reduction.

Eighth—Scouring. For this purpose the hooks are placed, with water, etc., in oblong barrels, which are kept in motion by steam power from one to two days, thus removing all scale and leaving the hooks ready for the ninth process of polishing.

Ninth—Polishing is performed in two ways. The hooks are placed in an oblong bag, with sawdust, and are rapidly shaken from end to end, until they become quite bright. The other way is to place them in barrels, moving more or less rapidly round on their bases, inclined at an angle of 85 degrees from the perpendicular. It is found that this inclination has a greater and more certain effect toward the end in view than an upright or horizontal position would have.

Tenth—Consists in the application of various methods of protecting the hooks from the corrosive action of water. Japanning—that is, giving the hooks several coats of a specially prepared black Japan; tinning—or coating them with tin; rust-proofing, browning, bluing, and coloring them red for worm fishing, or blue, green, yellow, etc., for fly dressing.

One factory alone in England turns out an average of 7,000,000 fish hooks a week.

Nearly all the best known hooks are numbered alike, starting with a hook which measures about 7-16 inch from the point across to the shank and is called No. 1. From that, hooks down to the smallest in common use, No. 15, although one hook is made as small as No. 20, which is 3-16 inch. The larger sizes start from No. 1 and run up in naughts to No. 10-0 and even 14-0, the larger sizes being used for salt water fishing.

Cincinnati bass hooks have independent numbers starting with No. 30, the smallest of which measures ¼ of an inch and going up to No. 16, which is 13-16 of an inch. Number 24 corresponds with No. 1 in ordinary styles.

The Kinsey is also oddly numbered, ranging from No. 24, the smallest, up to No. 6, the largest. No. 16 corresponds with No. 1 of the common hooks.

A FAMILY OF NAVAJO INDIANS.

THE Navajo Indian family lives in the Pueblo province. They belong to the Athapascan family, whose home is in northwestern Canada and central Alaska. They are among the most interesting tribes of the United States since, under Spanish direction, they laid aside their wild hunting habits, becoming herdsmen of sheep and other domestic animals and learning to weave and to work in metals. Their kinsmen, the Apache, on the other hand, fled from the conquerors and remained little affected by civilization down to the present time.

A FAMILY GROUP OF NAVAJO INDIANS.

The group includes three figures. The man is at work with modern implements of iron, shaping the silver ornaments so skillfully wrought by the workmen of his tribe. Two women are engaged in the most notable industry of this people, the spinning of yarn from native wool and the weaving of blankets.

Our illustration is taken from the United States National Museum report.

LORD KELVIN AND HIS FIRST TEACHER IN NATURAL PHILOSOPHY.

SOME interesting early recollections were related by Lord Kelvin on October 17, on the occasion of the unveiling of a stained glass window, by Henry Holiday, in the Bute Hall of the University of Glasgow in memory of John Pringle Nichol, LL.D., professor of astronomy, 1836-1859, and his son and daughter, John Nichol, LL.D., professor of English language and literature, 1862-1889, and Mrs. Jack, who was born in 1837, in the University, and died there in 1901. Prof. J. P. Nichol was the author of numerous valuable works, including the famous book on the "Architecture of the Heavens." The account which Lord Kelvin gave of his own young days at Glasgow College is full of interest, and his testimony to the impulse he received from his early teacher will be an enduring tribute to Nichol's memory.

In the course of his remarks, Lord Kelvin said: Principal Story, you recall to my mind the happy days of long past years, 1836, when John Pringle Nichol came to be professor of astronomy in the University of Glasgow. From the time he first came among us—I say among us, because I, as a child, was not then a member of the university, but an inhabitant of the university—when Dr. Nichol, as we then called him, came among us, he became a friend of my father, and that friendship lasted to the end of my father's life. I may also claim that I became a student of Dr. Nichol's from the time he first came to Glasgow. Year after year passed, and I still remember his inspiring in-

fluence. The work on which I am engaged at this day is work to which I was initiated in the years of 1837, 1838, and 1839, when I was a child. The summer of 1840 is for me a memorable summer, a year of brightness in my memory. I had been for one session a student in the natural philosophy class of the university conducted by Dr. Nichol. From beginning to end, with the exception of a few days, when my predecessor, Dr. Meikleham, began the course, which he could not continue on account of his health, the class in natural philosophy, in the session 1839-40, was taught by Dr. Nichol. He came on short notice to occupy the post, and he did it in a most admirable manner. I lately had the opportunity allowed me by my friend and colleague, Prof. Jack, to see a manuscript book of John Pringle Nichol's, a book of exercises and preparations for the natural philosophy class. I was greatly struck with it, and much interested to see in black and white the preparations he made for the splendid course of natural philosophy that he put us through during the session 1839-40. In his lectures the creative imagination of the poet impressed youthful minds in a way that no amount of learning, no amount of mathematical skill alone, no amount of knowledge in science, could possibly have produced. For, many years afterward, one of the most important affairs I have ever had to do with began with what I learned in the natural philosophy class in that session. I remember the enthusiastic and glowing terms in which our professor and teacher spoke of Fourier, the great French creative mathematician who founded the mathematical theory of the conduction of heat. I was perfectly astonished. I remember how my youthful imagination was fired with what I heard from our teacher. I asked him, "Do you think I could read it?" He said, "The mathematics is very difficult." At the end of the session I got hold of the book ("Théorie Analytique de la Chaleur") out of the university library, and in the first half of the month of May, 1840, I had—I will not say read through the book —I had turned over all the pages of it. Then we started out from Glasgow for Germany, the joint families of my father, my brothers and sisters, and our friend Dr. Nichol and Mrs. Nichol, and John Nichol and Agnes Jane Nichol. The two families made together a tour in Germany, and during two months or six weeks in Frankfort, Mrs. Nichol and her two children were with my father and his family every day while their father went on tour to the Tyrol. Excuse me for speaking of those old times. I am afraid I have trespassed on your patience. These recollections may be nothing to you, although they are dear to me. They are, indeed, closely connected with the subject of the present meeting.

While we were encamped for a time in Bonn, Dr. Nichol took me and my elder brother on a walking tour in the volcanic region of the Eifel. We had four days of intense enjoyment, and the benefit of what we learned from him and saw around us in that interesting region remained with my brother all his life, and remains with me.

I have to thank what I heard in the natural philosophy class for all I did in connection with submarine cables. The knowledge of Fourier was my start in the theory of signaling through submarine cables, which occupied a large part of my after life. The inspiring character of Dr. Nichol's personality and his bright enthusiasm lives still in my mental picture of those old days.

The old astronomical observatory—the Macfarlane Observatory—was situated in the upper part of the old college green, or garden, as we used to call it, behind the college, off the High Street. I do not suppose any person here ever saw the old college green, but you have all read of it in "Rob Roy," and of the duel between Osbaldistone and Rashleigh. I do not remember the details of the duel, but I remember it was appointed to be fought in the upper part (at least I have always assumed, in my mind, it was the upper part) of the college garden of the University of Glasgow. The garden was in two parts, the lower on the near side of the Molendinar, the upper on the higher ground beyond the stream, which we crossed by a bridge. Has any person here ever seen the Molendinar? There used to be mills on it, I assume, from the name. It is now a drain! Before we left the old college it was covered in. We had still the upper and lower green, but the Molendinar flowed unseen for many years after the university left the old site. I remember in the Macfarlane Observatory beautiful experiments on light shown us in the most delightful way by Dr. Nichol, Grimaldi's fringes by sunlight, and prisms showing us splendid solar spectra, and telescopes, and brilliant colors on a white screen produced by the passage of polarized light through crystals. He gave us firmly the wave theory of light, and introduced us to Fresnel's work. As he appreciated Fourier, so he appreciated Fresnel, two of the greatest geniuses in science, and fired the young imagination with the beautiful discoveries of those men. In that old observatory in the high green, and in the natural philosophy class-room of the old Glasgow college, was given to me the beginning of the fundamental knowledge that I am most thoroughly occupied with to this very day, and I am forcibly obliged to remember where and when my mind was first drawn to that work which is a pleasure to me, and a business to me just now, and will, I hope, be so for as long as I have time to work. You can imagine with how much gratitude I look upon John Pringle Nichol and upon his friendship with my father. His appointment as professor of astronomy conferred benefit, not only upon the University of Glasgow, but also upon the city and upon Edinburgh, and the far wider regions of the world, where his lectures were given and his books read. The benefit we had from coming under his inspiring influence, that creative influence, that creative imagination, that power which makes structures of splendor and beauty out of the material of bare dry knowledge, cannot be overestimated.

Wireless telegraphy has at last made its entry into China. The first station, built after the Marconi system, has been built at Pekin. Wireless telegraphy as an auxiliary defense for the legations has long been talked of, but to Italy is due the credit of its practical results.

ELECTRICAL NOTES.

The bronze shield subscribed for by the students of the Institution of Electrical Engineers at the beginning of the present year has now been placed upon the tomb of Volta at Camnago, near Como. The ceremony of fixing it in place was performed on Sunday, October 4, with many expressions of international good feeling, in the presence of Prof. Count Alessandro Volta, Cav. Franchi, the Sindaco of Camnago, with several members of the Volta family, and a number of other guests. The shield is mounted on a slab of green marble supported on granite in front of the tomb. The electrotype reproduction, which was officially deposited on the tomb on the occasion of the visit of the Institution in April last, has been transferred to the civic museum in Como, where it is placed in the collection of Volta relics.

Gutta-percha Supply.—There is always a fear in the electrical as well as other trades that there may one day be a shortage of gutta-percha, and it is therefore a matter of general importance to find a substitute or an addition to the sources of supply. This, the Colonial Economic Committee of Berlin announces, is now in prospect of being discovered. The utility of the gutta-percha discovered by the expedition which was undertaken to New Guinea under the leadership of Herr Schlechter has so far been established that it may be regarded as suitable for cable purposes as an admixture, and, if carefully obtained, to be suited for cables in a pure condition. Large quantities of gutta-percha have been obtained from New Guinea, and are at present being tested. The Secretary of State for the German Post Office, it is further stated, has identified himself with this movement, and has granted a large sum of money to cover the preliminary expenses.

Two sets of cotton, ramie, or silk threads are used in the manufacture of a new German metallically skeletonized earthy incandescent structure for electric lamps and gas or vapor burners. One set is impregnated with a solution of nitrates of refractory oxides, while the other set is treated with such salts of the platinum group as are capable of leaving behind a body of homogeneous metal when exposed to a moderate heat, such, for instance, as the compounds formed by the metals or their halogens with aliphatic sulphur derivatives, particularly the nitrates of the sulphine salts. The impregnated threads are well dried, and compound threads are formed in which threads of the first kind are coiled round so as to cover threads of the second kind. These are then formed into the required shape and exposed to a calcining heat to burn the fiber, to reduce the platinum salts to the metallic state, and to convert the earthy salts into oxides. The structure obtained is finally treated with a solvent for removing the oxide crust.

A German contemporary gives the results of the work of Messrs. Elbo and Nuebling on the production of various lead salts by electrolysis. They succeeded best in obtaining lead tetrachloride. The vessel used for this purpose consisted of a receptacle of glass with a porous cell arranged therein. In the cell there was suspended a lead plate, serving as cathode; on both sides of the cell strips of lead were fixed which served as anodes, and on the bottom of the glass vessel there rested a carbon plate, serving as auxiliary anode. The liquid in the cathode cell was dilute hydrochloric acid of about 1.1 specific gravity, while a 1.8 specific gravity acid was used in the anode compartment. The temperature must be below 10 deg. C. The idea of using different anodes is that dichloride of lead is formed at the regular anodes, while free chlorine is generated at the carbon anode, which chlorine then effects the conversion of the dichloride of lead into the tetrachloride. The authors isolated various double salts of this substance. They also worked with hydrobromic, hydroiodic, chromic, phosphoric, and hydrofluosilic acid as electrolytes.

Some figures have been published showing the loss of illuminating power of lamps due to globes. The results given below relate to a series of trials made with a Nernst lamp, which was first placed, by way of comparison, in a thin frosted glass globe. The illuminating power was determined by a Weber photometer. The lamp unienclosed by any globe or chimney gave the light of 81.8 English candles, and the loss resulting from surrounding it with different materials will be seen from the following figures: Concerning globes first, the illuminating power measured horizontally with "holophane" was 70.30, a loss of light equal to 14.1 per cent; with prismatic glass the figures were 65.80 and 19.6 respectively; with rose "holophane," 64.30, 20.8; white opal, 38.30, 53.2; yellow opal, 33.00, 59.7; ruby opal, 28.50, 65.2; rose opal (grooved), 22.90, 72.2; rose opal (light), 19.90, 75.6; and with green opal (light), 18.30 and 77.8. For colored chimneys the figures given are as follows: With amber glass the illuminating power is 71.30, the loss being 12.8 per cent; with white opal, 51.80, 36.7; and with light blue the figures are 37.50 and 54.2 respectively.

In order to avoid the irregularities due to the evolution of hydrogen in the electrolytic deposition of metals, the use of a rotating cathode has been tried by Messrs. F. A. Gooch and H. E. Medway, and found to be satisfactory. According to the Journal of the Chemical Society, as cathode, a platinum crucible is used, and it is fixed to the vertical spindle of a motor. The solution to be electrolyzed is contained in a glass vessel on a rising table. A strip of platinum is used as anode. At first, the cathode is immersed in the solution to only about two-thirds of its depth, and it is rotated (600-800 revolutions per minute) until most of the metal is deposited. Water is then added, so that the whole crucible becomes immersed, and the electrolysis is carried to completion. The deposit is washed and dried in the ordinary way. Results are given in the paper showing that the method is satisfactory for the deposition of copper (from copper sulphate solution containing free sulphuric acid or even nitric acid), silver (from potassium cyanide solution), and nickel (from an ammoniacal solution). As a comparatively high current strength may be used, the electrolysis can be carried out much more quickly than by the ordinary process.

ENGINEERING NOTES.

In 1892 the Japanese mercantile fleet was the thirteenth in the world. In 1901 it was the eighth, and it is rapidly coming to the position now occupied by the Japanese navy, which is seventh. It is interesting to learn that there has just been completed in this country a salvage steamer of 712 tons and 690 indicated horse power with equipment of the most up-to-date description.

The Russian railroad report for 1901 shows that in that year there were 9,890 accidents causing death, injury, or material loss. Among these accidents were 1,012 collisions and 1,521 derailments. Misplaced switches alone caused 184 collisions and 458 derailments. By these accidents 1,490 people were killed and 3,757 injured; 103 of the killed and 682 of the injured were passengers; 506 killed and 2,053 injured were employes.

A Jacquard card-punching machine effecting the pointing of the most delicate details with absolute mathematical precision without possible error in the punching and producing patterns which are immediately available for use with Jacquard embroidery machines, has been designed by two Polish engineers. The machine is composed of two essential parts—(1) the apparatus for reading in or pointing by means of which the operator follows the contour of the design for reproduction to determine the position of the holes in the card or pattern; (2) the punching apparatus which registers step by step upon a band or paper, punched according to any particular combination, the actual value of the intervals, according to vertical and horizontal displacements of the table, carrying the sketch or pattern in the reading-in apparatus.

What is said to be the largest and most powerful towboat every built for the Mississippi River was recently constructed at Dubuque, Iowa, to the order of the Monongahela River Consolidated Coal and Coke Company, Pittsburg, for use in taking down river the immense fleets of coal barges. She is the usual sternwheel type of steamer which predominates on the Western rivers, but in size is very much larger than any boats yet built, her "over all" length being 318 feet. The hull is built of steel from the boiler deck down, the general dimensions being as follows: Length of deck, 277 feet; beam, 61 feet; depth, 7 feet. To give sufficient strength to this long and very shallow vessel 3 fore-and-aft bulkheads are fitted, and a system of chains and braces, similar to the hog frame in sidewheel steamers, is built to take up the strains due to the heavy weights resulting from placing the boilers forward and the engines aft.

For many years the fact has been realized that the blast furnace is practically a huge gas producer, and partial utilization of the fuel formerly wasted has been extensively practised in Great Britain and in other countries. More recently considerable progress has been made in utilizing blast-furnace gases by means of the internal combustion engine. As Mr. Humphreys showed in a recent paper, there were in operation at the end of the year 1902 fully 327 gas engines capable of developing an aggregate of more than 180,000 horse power, and at the present time it is probable that the engines already built or in course of construction represent a total of some 220,000 to 230,000 horse power, most of these engines being operated or intended to operate with furnace gas. In iron and steel works the waste gas is chiefly used for firing boilers supplying steam to steel plant, rolling mills, and other machinery. The fact is now recognized that this is a roundabout method, and there is reason for believing that the continued improvement of large gas engines will ultimately render the use of steam unnecessary in large iron works. As an indication of movement in this direction we may mention the fact that the Buffalo works of the Lackawanna Steel Company are now being equipped with three new plants, one including eight 1,000-horsepower gas engines for driving dynamos, and two others having sixteen 2,000-horsepower engines for driving blowing engines.

Prof. H. L. Callendar, F. R. S., before the British Association drew attention to the self-recording instruments made by the Cambridge Scientific Instrument Company, chiefly on his suggestion, as eminently fitted for meteorological observations. The thermometers are platinum resistance thermometers of the well-known Callendar-Griffiths type. They are buried horizontally in iron tubes. When taking his first observations of underground temperatures, years ago, at Montreal, he said, he buried his thermometers vertically, and was called every hour by an alarm clock—as long as he could stand that. His new thermometers, buried 4 inches, 10 inches, and 20 inches below the surface, show faintly or distinctly a diurnal period, which, however, does not directly seem to depend upon heat diffusion and conduction, but rather on percolation of water. The new registering instruments embody several improvements, not previously noticed in our columns, and requiring a special description; they comprise an exceedingly delicate relay and an integrating planimeter, one arm of which is attached to the writing style, the wheel rolling on the drum surface. This integrator was very useful in sunshine recorders, as it gave the total quantity of heat received. The bolometric sunshine receiver used consists of a differential pair of flat platinum thermometers—one blackened, the other bright—exposed side by side. The apparatus records the temperature difference, which is a measure of the vertical radiation component. Prof. Callendar showed comparative records, from burning glasses and from his own instruments, demonstrating that the former are quite unreliable; a thick line is burned, for instance, although the sun was repeatedly obscured, and no sunshine recorded at all, although the sun was shining brightly for many hours. He also exhibited curves marking the suitability of the instruments for metallurgical work (temperatures and recalescences of cooling iron and steel), and for measuring the discharges of a few cells, as well as the load on 1,500-kilowatt generators. It is noteworthy that the apparently slow instruments record cycles of 1-80 second correctly. Mr. Boys, Prof. Turner, and Dr. Shaw complimented the author on the remarkable success obtained.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Brewing Industry of Kulmbach.—For many centuries the brewing of beer has been the chief occupation of the inhabitants of Kulmbach. Until about 1835 the production of beer in this part of Bavaria was only sufficient for local consumption. The introduction of machinery, aided by steam, however, greatly increased the output, so that it soon found a ready sale, not only in Germany, but in every country in the world. The following table will show the increase in the export of this beer during the past seventy years:

	Gallons.
1831	4,385
1851	351,851
1871	1,950,631
1891	11,933,690
1899	19,020,240

The capital necessary to run the different breweries in Kulmbach, with all the side lines connected with them, for one year is estimated at $2,500,000. This sum is spent chiefly in the purchase of barley, hops, malt, coal, etc. Fully 1,000 skilled laborers are employed, while the number indirectly dependent upon the industry is much larger. The annual sum paid out to directors, clerks and technical overseers amounts to $166 000.

The breweries of Kulmbach keep alive many side industries. The numerous steam engines of all the breweries together furnish 1,600 horse power, while four of them have their own railway switch yards. Over 200 refrigerator cars carry the beer of the 17 breweries, not only to every part of Germany and neighboring countries, but especially to the seaports of Hamburg and Bremen for shipment to distant lands. The brewing of beer, as an industry, is of incalculable value to the agricultural interests of Bavaria, as immense quantities of grain and hops are necessary to keep the breweries running at their utmost capacity.

The internal arrangements of these great establishments are kept at the highest point of technical perfection. Their proportions will be appreciated from the following statistics covering one of the leading establishments: One seasoning tank of 6,340 gallons capacity; three huge malt vats with 3,434, 5,943 and 6-868 gallons capacity, respectively; two cooling reservoirs which will hold 4,642, and 5,679 gallons of beer respectively; together with malt elevators, ice-making machines, fermentation tanks, and revolving cranes. The steam necessary to drive the machinery is generated in two large boilers, each having an extraordinary capacity for creating heat. In connection with these boilers there are four subterranean pits, each capable of holding 27,557 pounds of coal. The entire brewing outfit, with tanks, vats, reservoirs, etc., was furnished by a Munich firm, while the machinery and engines were manufactured by a machine factory in Augsburg. The electrical dynamos and apparatus were furnished from Berlin and by a local firm. The smokestack which rises over the brewery is 147 feet high and nearly 5 feet in diameter.

The beer brewed in Kulmbach is usually heavy in character, dark in color, and especially adapted for export. The sale of this beer in Saxony, Silesia, and North Germany has been considerably curtailed since 1901. Kulmbach beer is regarded as an article of food in Germany, especially by laborers who work in factories. When better times were prevalent throughout the country, the middle classes, as well as the working classes, preferred this genuine Bavarian beer in spite of the fact that it was more expensive. The present depressed industrial conditions generally throughout the empire have imposed upon the people the necessity of using the greatest economy, and the mild local beers produced all over Germany are coming more and more into favor, not on account of the quality, but because the price is such that these grades of beer are always within reach of the masses. The following will show the difference in price between local and imported beer as it is sold in Eibenstock per quart: Ordinary local, 3 cents; local lager, 7 cents; local white, 10 cents; Munich, 11 cents; Kulmbach, 12 cents; Pilsen, 14 cents.—Ernest L. Harris, Commercial Agent at Eibenstock, Germany.

Machinery Insurance in Germany.—To the numerous branches of the insurance business—as, for instance, life and fire insurance, insurance against burglars, against damage caused by hail, bursting of water pipes, etc.—quite recently a new and important one has been added in these parts, viz., the insurance of machinery.

The Stuttgarter Mit- und Rückversicherungs Aktiengesellschaft (Mutual Reinsurance Company of Stuttgart) is the first to take up this, to Germany, novel idea. Among the branches of trade which are likely to take an interest in this insurance, the electric industry ought to be mentioned in the first place; its extensive wire and cable nets, its many masts and poles, etc., are exposed to the severity of storm and weather all the year round, so that in spite of every care and attention serious harm may be done at any time. But other branches of trade will find this sort of insurance a benefit. The blown-down chimney of a factory or a boiler explosion may cause serious harm to machine houses, or an inundation may damage turbine wheels and other machinery. In such cases the benefit of the injured parties being insured is apparent.

The company also insures against damage done to machinery by negligence or inexperience on the part of workmen. It is almost impossible to have at all times well-trained and experienced hands in one's employ, and it is by no means an infrequent occurrence that machinery comes to more or less serious harm through the fault of some hand or other, and the chances of the owner of a factory being able to recover from such loss are very few and far between. The prospectus of the company also includes damages caused by deficiency of the material out of which machines are manufactured if such faults are detected after the term of the manufacturer's guaranty has elapsed. Some machines work beautifully for years and break all of a sudden, owing to a trifling fault in the material. In many cases the manufacturer of the machine which has suddenly come to harm will do his best to repair damages, but this is not always possible, and either a lawsuit, with all its anxieties and uncertainties, will have to be gone through with or the loss cannot be made good.

This new insurance departure will include not only machinery in the strict sense of the word, but also all sorts of apparatus, belts, chains, pipes, cables, locks, foundation walls, etc.

In support of loss claims, the bill of repairs or of the new machinery purchased to replace the damaged machinery must be produced and submitted. The premium will depend upon the total value of the insured machinery, and will be different for machinery which is stationary and under cover from that which will have to be paid for machinery exposed to the open air and for movable machinery.—Oliver J. D. Hughes, Consul-General at Coburg.

Recovery of Gold in Combination with Tellurium and Selenium.—In compliance with a personal letter dated June 29 from the chief of the Bureau of Foreign Commerce, asking for a special report in regard to the most effective process known and practised in Germany for recovering gold from ores containing also tellurium and selenium, I have to report as follows:

Tellurium, which has been known as a primitive element for more than a century, and selenium, which is of more recent discovery, are distinguished in metallurgy as metals which combine chemically with gold.

The extraction of gold from telluride and selenic ores is therefore one of the most difficult problems in practical metallurgy. The discovery in recent times of extensive deposits of telluride-gold ores in Western Australia and the United States—notably at Cripple Creek, Col.—has given special importance to this subject, and it has been found on investigation that, so far as can be ascertained, the most improved and effective method known in this country is one perfected and practised by the London and Hamburg Gold Recovery Company, which has extensive reduction works at Hamburg, with offices at No. 20 Frauenthal in that city. The company works the telluride-selenic ores from Western Australia.

Of the process itself it has only been possible to ascertain that it is partially patented and partially held as a secret which the specifications of the patent do not disclose. What is known is that by this process telluride and selenic ores containing gold are pulverized and digested in a solution of cyanide of potash and cyanide of bromium, in proportions of 75 per cent of the former to 25 per cent of the latter. The method by which the gold is precipitated from the solution is part of the carefully guarded secret concerning which no information can be obtained, but it is certain that the process recovers 95 to 96 per cent of the gold contained in the ores, and this proportion is often as high as 97 or even 98 per cent.

The company, while naturally refusing to disclose further details of its perfected method, will be willing at any time to make tests of American ores and give exact reports of results. Samples of ore for this purpose should contain not less than 200 pounds.—Frank H. Mason, Consul-General at Berlin, Germany.

Mail Matter in Care of Consuls.—Mail matter, such as registered letters, matter of declared value, money orders, and ordinary packages intended by travelers, seamen, etc., to be received by the addressees at the consulate of their country, lacking the words "Zu Haenden des," "abzugeben an," "fuer," and "unter" (per) "adresse des," as well as the words "aux soins de" (care of) and "pour remittre à," will, according to the post-office regulations, be delivered to the consul-general, consul, or other qualified official representative. The omission of these words is considered to occur through ignorance of the post-office regulations or to oversight on the part of the senders, and the Federal Post-Office Department of Germany has therefore decided that in cases where in addition to the name of the addressee only the name of the consulate is added, without any of the above-mentioned words, the mail matter shall be delivered to the consular officer without further formalities other than the customary receipt by him.—Richard Guenther, Consul-General, Frankfort.

Korean Grain for Vladivostock.—Southern Korea has a good harvest of cereals this year. Prices for cereals are high in Vladivostock, and are likely to go higher. Russian merchants are seriously considering the profit in importing grain from southern Korea. The Japanese are already exporting grain from Fusan, and also rice. The grain could easily be brought here from Masampo, where there is a Russian vice-consulate to advise. Prices are very low in Masampo, and transportation would only cost a few cents per hundred. A local measure (about 27 pounds) of rice, uncleaned, costs 45 to 55 sen Japanese (22 to 27 cents). Cleaned rice is sold by measure of about 35 pounds at 1.50 yen (74.7 cents) to 1.80 yen (90 cents). Barley is harvested in the spring. One measure of 27 pounds costs about 33 sen (16 cents). Payment can be made in local coin. Samples of this Korean barley and rice have been on exhibit at the office of the board of trade broker. As usual, there is much talk here about what Siberian merchants could do in these lines; but meantime the Japanese and Chinese are busily engaged in the traffic.—R. T. Greener, Commercial Agent at Vladivostock.

Helps to American Trade in Japan.—In his report on the trade and commerce of the consular district of Nagasaki, Japan, for the year 1902, Consul C. B. Harris, suggesting a way to increase American trade, says:

"It is greatly to be desired that additional facilities be secured to increase the sale of American products in this Empire. There seems to be now no better or more convenient way to reach that end than for the American cable system, lately landed in the Philippines, to arrange for and extend their system to Japan. It is believed that on the inauguration of direct cable connection with the United States our trade in this Empire will very materially increase."

In the same report, speaking of the Mitsu Bishi Dockyard, Engine and Shipbuilding Wo'ks, Consul Harris says that the company's orders have been and are now, even for American goods, almost wholly placed in Great Britain. There exists no good reason why their purchases should not be made to quite an extent in the United States, provided direct solicitations be made by our manufacturers.

American-Spanish Trade.—In his annual report showing the trade and industries of Carthagena for the fiscal year ended June 30, 1903 (filed for publication in Commercial Relations), Consul Joseph Bowron thus treats of American-Spanish trade:

Letters, circulars, and catalogues are plentiful, but they will not create business until Americans are prepared to quote cost, freight, and insurance to Spanish ports, on the basis of English or French money, and give respectable customers such ordinary commercial credits as they can readily obtain from European shippers.

The enhanced cost of American goods, due to the absence of direct steam communication between United States and Spanish ports, has been referred to in previous reports. In this connection I may say that bread is essentially the staple of life throughout Spain, and that in this consular district the bulk of the bread is made from flour which is brought hundreds of miles from Catalonia and the north. With a treaty of commerce and direct steam communication, I have no doubt that American flour could win and hold this market.

Agricultural and Woodland Statistics of Germany.—According to the latest agricultural census of Germany, taken in 1895, there existed then in the empire 5,558,-317 farming establishments. Of these there were 3,236,-367 containing 5 acres or less of land. Of all farming acreage 61.1 per cent was planted in farinaceous cereals—grain, beans, peas, etc. There were 69,393,000 plum trees, 52,332,000 apple trees, 25,116,000 pear trees, and 21,548,000 cherry trees. Statistics for the tobacco culture show that 41,658 acres were planted with tobacco in 1901 in Germany, producing 40,018 metric tons of dried tobacco leaf. In the official count of 1900 the area covered by forests in Germany aggregated 34,989,-672 acres, of which 17,443,188 acres belonged to the States and municipalities. These, as also the woodlands of private individuals, are kept in a high state of scientific cultivation, as the preservation of forests is considered to be a matter of great importance for economic and hygienic reasons.—Simon W. Hanauer, Deputy Consul-General, Frankfort.

Meat-Inspection Decision in Germany.—It having been held by meat importers, and even by some of the meat inspectors, in view of the rigid inspection to which meats were subjected in Germany, that meat imported from the United States did not require the official certification of the American inspectors that pork had been subjected to microscopical examination and found to be "wholesome," the Imperial Chancellor of Germany has just delivered an opinion on this subject, declaring the new German inspection law did not abrogate the imperial decree of September 3, 1891, which demands the production of the above-mentioned official American certification for hogs, pork, and sausages of American origin. This stipulation remains in full force as long as the decree is not rescinded.—Simon W. Hanauer, Deputy Consul-General, Frankfort.

German Coke for Mexico.—It is reported that the steel works at Monterey, Mexico, has just made a contract with a Westphalian company for the delivery of 50,000 tons of coke. To some this may perhaps seem extraordinary, considering the close proximity of the American coke ovens. Mexico imported quite a lot of coal from Mobile, Ala., during the year 1901, but the importation was cut short because of the faulty transportation facilities. The exportation of Alabama coal is increasing as rapidly as the transportation thereof will allow. It is even more surprising that about 40,-000 or 50,000 tons of coke are annually imported into California from England and Germany, when Washington State has some of the finest coking coal beds in the world.—Brainard H. Warner, Jr., Consul, Leipzig.

Chinese Trade with Russia.—The results of the excursion of Chinese merchants to European Russia, mentioned in a former report from this commercial agency, is seen in the determination to open warehouses for Chinese products at St. Petersburg and Moscow. They will bring their native commercial agents and business staffs along. The shops will be built in Chinese style. From St. Petersburg and Moscow branch establishments are proposed at Warsaw, Wilna, Helsingförs, Riga, Kief, and Odessa.—Richard T. Greener, Commercial Agent, Vladivostock.

Machine Tools in Germany.—During the first six months of the present year Germany exported machine tools aggregating 9,700 tons (of 2,240 pounds) and imported in the same period 1,053 tons, the latter coming principally from the United States. The markets for German-made machine tools are mainly Russia, Austria-Hungary, Italy, Belgium, and France.—Simon W. Hanauer, Deputy Consul-General, Frankfort.

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Other Reports can be obtained by applying to the Department of Commerce and Labor, Washington, D. C.

TRADE NOTES AND RECIPES.

Heat-proof Putty.—Mixing a handful of burnt lime with 120 grammes of linseed oil, boiling down to the usual consistency of putty, and allowing the plastic mass to spread out in a thin layer to dry in a place where it is not reached by the sun's rays, yields eventually a very hard putty. When required for use it is made plastic by holding over the funnel of a lamp; on cooling it regains its previous hardness.

Preserving Eggs.—Eggs can be preserved for winter use by coating them, when perfectly fresh, with paraffin. As the spores of fungi get into eggs almost as soon as they are laid, it is necessary to rub every egg over with chloroform or wrap it a few minutes in a chloroform soaked rag before dipping it into the melted paraffin. It only needs an entrance of a trace of the chloroform into the interior of the shell to permanently inhibit the development of such germs as may have gained access to freshly-laid eggs. The paraffin coating excludes all future contamination from germ-laden air and with no fungi growing within they retain their freshness and natural taste. Eggs packed in lime soon acquire an unpleasant taste that to some people is almost as bad as that of incipient decomposition. Lime packing is the one most used in this country.—Drug. Circ.

Clothes Cleaning Fluid.—An efficient clothes cleaning solution for the rapid removal of oil stains, paint, grease, and dirt that is at once active and pleasant to use can be prepared from the following ingredients:

Borax	1 ounce
Castile soap	1 ounce
Sodium carbonate	3 drachms
Ammonia water	5 ounces
Alcohol	4 ounces
Acetone	4 ounces
Hot water to make	4 pints

Dissolve the borax, sodium bicarbonate and soap in the hot water, mix the acetone and alcohol together, unite the two solutions and then add the ammonia water. The addition of a couple of ounces of rose water will render it somewhat fragrant.—Drug. Circ.

Cleaning of Bronzes.—*Gilded.*—1. Commence by removing the spots of grease and wax with a little potash or soda dissolved in water. Let dry, and apply the following mixture with a rag: Carbonate of soda, 7 parts, whiting 15, alcohol (85 deg.) 50, water 125 parts. When this coating is dry, pass over it a fine linen cloth or a piece of supple skin. The hollow parts are cleaned with a brush.

2. After removing the grease spots, as specified above, let dry and pass over all the damaged parts a pencil dipped in the following mixture: Alum 2 parts, nitric acid 65, water 250. When the gilding becomes bright, wipe and dry in the sun or near a fire.

3. Wash in hot water containing a little soda, dry, and pass over the gilding a pencil soaked in a liquid made of 30 parts nitric acid, 4 of aluminium sulphate, and 125 parts of pure water. Dry in sawdust.

4. Immerse the objects in boiling soap-water, and facilitate the action of the soap by rubbing with a soft brush; put the objects in hot water, brush them carefully, and let them dry in the air; when they are quite dry, rub, with an old linen cloth or a soft skin, the shining parts only, without touching the others.

Varnish.—Imitation of Gilding. There are varnished bronzes so nearly resembling gilded bronzes in appearance that they may be easily confounded. To distinguish them, it is sufficient to touch them with a glass rod dipped in a solution of mercury bichloride (corrosive sublimate). If the object is gilded, the point touched will not change in color; if not, a brown spot will be formed.—Translated from the Formulaire Industriel.

Use of the Word "Salt."—The most common use of the word "salt" is as a name for chloride of sodium. Chemists usually apply the word to all substances produced by the union of an acid and a base. As a survival of the antiquated nomenclature of early chemists the popular names of magnesium sulphate and sodium potassium tartrate are Epsom salt and Rochelle salt. As the old use of the word salt still persists in trade receipts and formulas it is sometimes quite puzzling to a pharmacist to tell what is meant when one of these is brought to him to compound. The following list from "Bayley's Chemist's Pocket-Book" covers nearly all that are likely to recur in this manner:

Old Name.	New Name.
Argillaceous marine salt	Aluminium chloride
Cathartic bitter salt	Magnesium sulphate
Common salt	Sodium chloride
Digestive salt	Potassium acetate
Diuretic salt	Potassium acetate
Epsom salt	Magnesium sulphate
Febrifuge salt	Potassium chloride
Fixed ammoniacal salt	Calcium chloride
Glauber salt	Sodium sulphate
Marine salt	Sodium chloride
Microcosmic salt	Sodio-ammonium phosphate
Nitrous ammoniacal salt	Ammonium nitrate
Periate salt	Disodium phosphate
Periate wonderful salt	Disodium phosphate
Polychrest salt	Potassium sulphate
Salt of amber	Succinic acid
Salt of benzoin	Benzoic acid
Salt of canal	Magnesium sulphate
Salt of colcothar	Ferrous sulphate
Salt of egra	Magnesium sulphate
Salt of lemons	Potassium hydrogen oxalate
Salt of saturn	Lead acetate
Salt of sedlitz	Magnesium sulphate
Salt of seignette	Sodium potassium tartrate
Salt of soda	Sodium carbonate
Salt of sorrel	Potassium hydrogen oxalate
Salt of tartar	Potassium carbonate
Salt of vitriol	Zinc sulphate
Salt of wisdom	Ammonio-mercury chloride
Secret ammoniacal salt	Ammonium sulphate
Sedative salt	Boric acid
Spirit of salt	Hydrochloric acid
Sulphurous salt	Potassium sulphide
Wonderful salt	Sodium sulphide

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Scientific American Supplement.

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